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NOTES ON A SPECIES OF PELOMYXA.

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IN rearing amœbas for class use, as every one knows, many interesting protozoa make their appearance. The Pelomyxa described in this communication developed in great numbers, something over a year ago, in a "culture" which had been prepared for this purpose. The method of preparation was one that I have employed for several years, and is as follows. Into an ordinary wooden tub (2 ft. by 1 ft.) sand is poured to a depth of four inches. The tub is then put under the tap of a table aquarium, and flushed until the water is comparatively clear. A good handful of Nitella, two or three opened mussels, and a crayfish, cut into a couple of pieces, are thrown into the water and partially imbedded in the sand. The tub is left exposed to a north light from large windows, at a distance of some yards from the windows. As decomposition progresses, a very gentle stream of water is turned on for a short time every few days. After an interval varying from two or three weeks to two months, large amœbas (*A. proteus*) are found in abundance in the surface layer of the sand, and on the sides of the tub. Small amœbas frequently appear in numbers before

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the large ones come on. The commonest small form to appear is *A. radiosa* — occasionally *A. limax* (or some similar form). I have tried these tub cultures only during the warmer months of the year (April 1 to November 1). With rare exceptions they are successful. Mussels alone have frequently given me good amœbas, but the Nitella and the crayfish increase the chance of having enough to start with. The sand may come from anywhere, roadside or creek. The water is well water pumped into a reservoir tank. I am inclined to believe that a trace of mud, got along with the mussels or Nitella, is an advantage. But anything more than a trace is, here, sure to result in the development of Tubifex, which quickly spreads over the bottom, strewing it with fæces, while the amœbas, even if they get a start, gradually become scarcer, soon disappearing.

In the succession of organisms developing in such a culture, the bacteria are followed by the flagellate, and then by the ciliate Infusoria, both especially abundant in the surface film, where they feed upon the zoöglœa. A loose brown growth accumulates on the bottom, but more thickly on the wall of the tub. This consists of many things: fungus, hyphæ, bacteria, unicellular algæ, quantities of Infusoria, often Heliozoa (Actinophrys), and rotifers. The stuff gradually falls from the wall and accumulates on the bottom, round the edge. In this "growth" the small amœbas referred to above are often found, and in it *Stentor cœruleus* frequently develops in the greatest abundance. It is usually after this growth has begun to accumulate on the bottom, round the edge, that the large amœbas make their appearance. They are more abundant over the general surface of the sand than in the thick masses of brown stuff. By this time the Infusoria are no longer present in excessive numbers. The Entomostraca soon develop, and the amœbas gradually disappear. I think Cyclops is particularly destructive — it is constantly "rooting" in the sand. Frequently, before the arrival of the Crustacea, small planarians appear in numbers — *Microstomum lineare* has swarmed several times.

In a culture of this kind (mussels and Nitella both taken from a creek, the bottom of which in the particular locality is made up of soft mud, with abundant Tubifex), that had been

going during August, there appeared in the early part of September numbers of a large rhizopod belonging to Greef's genus Pelomyxa. After discovering the presence of the form, I examined the tub systematically and found that the Pelomyxas were about evenly distributed over the wall, and in the stuff round the edge, but were not present over the bottom, where Tubifex had already made its appearance. They were abundant. On the average, each pipetteful of stuff (about 2 cc.) contained a specimen, which could be detected at once with the naked eye in a watch glass. In the same brown growth *Stentor cæruleus* was present in great numbers, and the Pelomyxas were feeding chiefly on these. In the Pelomyxas recognizable pieces of Stentor were commonly present, and sometimes a whole Stentor still rotating. Unlike the Pelomyxas previously described, this form contained no mud nor sand.

The Pelomyxas continued to be abundant in the tub (preserving the same distribution) for nearly two months. Towards the end of this time they began to disappear, the Stentors going first. With the gradual disappearance of these forms, Crustacea, particularly Cyclops, developed. The probable share that Cyclops had in the destruction of the Pelomyxas was indicated clearly in the following case. On September 8, ten Pelomyxas were transferred to a small glass aquarium jar, together with some of the brown "growth" and a little Spirogyra. They were supplied, during the first few days, three times with Stentors in considerable number. Within five days the Pelomyxas increased in number to fifty odd. After a week or two, Cyclops began to appear, and the Pelomyxas diminished in number and soon disappeared. I never actually saw Cyclops seize a Pelomyxa, but the former was constantly darting into, or "rooting" in, the stuff in which the rhizopods lay. And the only animals observed in the jar, besides Cyclops and Pelomyxa, were small Infusoria.

In the following case the Pelomyxas obviously disappeared because of gradual starvation. In this case a number of the rhizopods were transferred, in September, to glass preparation dishes, of a size (30 mm. × 70 mm. in diameter) that would permit examination under a low objective. In these dishes was kept

clear water without any of the brown stuff or sediment, and the Pelomyxas were changed to fresh water occasionally. No Cyclops or other Crustacea developed in these dishes. For a time *Stentor cæruleus* was supplied, and later a small brown Stentor, Paramœcium, and other Infusoria. The Pelomyxas remained active and kept their size during this period, though they did not materially alter in number. After a few days they were no longer fed, though the dishes were kept supplied with fresh water. They gradually decreased in number, diminished very noticeably in size, and were very sluggish in their movements. The last of these individuals were made use of in early November. These starved individuals were about one-third the size of those originally put in the dish. It is possible of course that some division went on during this period of starvation, and that the shrinkage in size was not due merely to the loss of tissue.

To this form I have given the name of *P. carolinensis*. Its points of difference from the related species of Pelomyxa will be discussed later.

Description of Pelomyxa carolinensis.

Habitus. — The body, when viewed by reflected light, is white and conspicuous. When left for some time undisturbed (in small aquarium dishes suitable for microscopic observations), the body assumes a great variety of shapes, many of them indicating a high degree of consistency in the superficial layer of protoplasm. Owing to the large size of the species, these shapes may, with some success, be made out even with the unaided eye, though better with the help of a simple lens and low objective.

The body is very apt to assume an elongated, more or less rod-like shape, as in Fig. 1; sometimes enlarged at one end (clavate), as in Fig. 2. The elongated body may lie flat on the supporting surface, as in Figs. 1 and 2. More frequently the body is thrown into one or more curves, the animal resting on the bottom by its two ends, as in Figs. 3 and 4. Occasionally a Pelomyxa was observed in the remarkable attitude shown in

Fig. 5, a portion of the body resting on the bottom, while the rest of the animal, divided at the end into pseudopodia, projected freely upwards in the water. In this condition, Pelomyxa appears for the time being as an attached rhizopod with tentacle-like pseudopods, the nearest analogue to which is the interesting minute form *Stylamœba sessilis*, found by Frenzel [1] at Cordoba in Argentina.

If the animal in the undisturbed condition is not more or less rod-like, the body is frequently divided up into very long, slender pseudopodia, as in Figs. 6 and 7. In this condition the animal rests on the tips of certain pseudopodia, the rest of

Fig. 1.

Fig. 3.

Fig. 2.

Fig. 4.

Fig. 5.

Fig. 1. — *P. car.* as an opaque object. Simple, elongated condition. Zeiss $a_2 \times 4$. Reduced to ½.
Fig. 2. — *P. car.* as an opaque object. Clavate condition. Zeiss $a_2 \times 4$. Reduced to ½.
Fig. 3. — *P. car.* as an opaque object. Body an arc resting on the two ends. Zeiss $a_2 \times 4$. Reduced to ½.
Fig. 4. — *P. car.* as an opaque object. Body somewhat spirally curved, resting on its ends. Zeiss $a_2 \times 4$. Reduced to ½.
Fig. 5. — *P. car.* as an opaque object. Body in part resting on bottom, in part protruding up into water, with tentacle-like pseudopods. Zeiss $a_2 \times 4$. Reduced to ½.

the body not touching the surface. The other pseudopodia project freely in the water in various directions, and the whole body is thrown into boldly arching curves, which usually lie in several planes. When the animal is in this condition, with its irregular body extending in so many directions, it obviously dominates (*i.e.*, can gather food from) a much larger cubic space than when in the simple rod-like condition. Now in that aquarium jar in which the Pelomyxas were best fed, and in which they increased so considerably in number (ten to fifty in five days), some form of the rod-like shape was nearly universal. Here the food (Stentors and other Infusoria) was most abun-

[1] Untersuchungen über die mikroskopische Fauna Argentiniens. Protozoa. *Bibliotheca Zoologica*, Heft 12, 1892–97.

dant in the brown "growth," with which the bottom was strewn. With the food thus distributed, the worm-like shape was doubtless well adapted to the situation. On the other hand, in those dishes containing no sediment or brown "growth," but simply clear water, and in which the Pelomyxas did not increase in number, the irregular, branched condition (Figs. 6 and 7) was extremely common. In these dishes it is evident that food was scarce from the start, and the peculiar shape of the Pelomyxas is probably to be regarded as an adaptation to circumstances. We may think

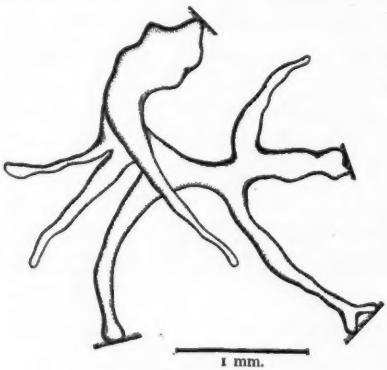

FIG. 6.

FIG. 7.

FIG. 6. — *P. car.* as an opaque object. Body thrown into bold curves and complexly branched, resting on bottom (indicated by lines) at four points. Remaining pseudopodia project freely into water. One millimetre drawn to same scale. Zeiss *A* × 2. Reduced to ½.

FIG. 7. — *P. car.* as an opaque object. Body thrown into two curves, lying in planes nearly at right angles with each other. Body rests on bottom (indicated by lines) at four points, one pseudopodium projecting freely upwards. Zeiss *A* × 2. Reduced to ½.

of the animals as thrusting their substance out in all directions of space, searching for food.

When brought on a slide in a drop of water, these animals assume the general shape of *Amœba proteus*. The body expands in a horizontal plane, and is, as a whole, applied to the surface over which it is creeping (Fig. 8). This is the case whether the drop be uncovered or covered — cover was always supported with wax feet, so as to permit free movement. This flattened shape is not directly caused by confinement between two surfaces (surface film and slide, or cover and slide), because it is also usually assumed when the Pelomyxa is first placed in

a watch glass with plenty of water. It would appear to be the shape into which the amœboid body, more or less contracted after the reception of a shock, normally expands, before assuming any more characteristic habitus. If the Pelomyxa, owing to the shock of having been transferred to the watch glass, has contracted into a very compact shape, it may (rare condition) throw out short radial pseudopodia all over its body, excepting the lower surface (applied to the glass), Fig. 9. This condition is transitory, soon passing into the stage shown in Fig. 8.

FIG. 8. — *P. car.* moving freely, on slide, under supported cover. Arrows indicate direction of endosarcal currents. Longitudinal, and papillose wrinkling at the ends of pseudopodia, out of which current is flowing. Only the most conspicuous vacuoles, nuclei, and albuminous globules represented. Zeiss *A* × 2. Reduced to ⅔.

Size. — In the relatively contracted shapes (Figs. 8 and 9) *P. carolinensis* measures about 1 mm. in diameter. The largest form actually measured, in which the body was of the slender irregular character shown in Figs. 6 and 7, measured in a straight line from pseudopodium tip to pseudopodium tip 2.8 mm. Some two hundred specimens of this species were examined by myself and the class demonstrator during September; and for the elongated shapes, the length may be said to vary from 1 to nearly 3 mm., the common length being 1.5 mm. to 2 mm. These measurements may

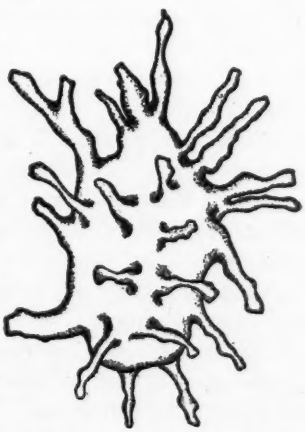

FIG. 9. — *P. car.* as an opaque object. Shortly after having been transferred to watch glass. Body covered with short radial pseudopods. Zeiss a_2 × 4. Reduced to ⅔.

be taken as characteristic of the adult condition, since the Pelomyxas were always picked out with the unaided eye, no effort being made to discover young forms with the microscope.

Structure of the Body. — There is a perfectly clear peripheral (ectosarcal) region, which in the living state is very narrow, being conspicuous only at the ends of expanding pseudopodia (Fig. 8). The granular, more opaque and fluid endosarc contains numerous nuclei, vacuoles, and other bodies. Though the endosarc is naturally lighter near the edge than further in, this difference in transparency is due to a difference in thickness and not to a difference in composition. The nuclei are very abundant, and scattered without order through the endosarc. They are elliptical in shape, and measure $18\,\mu \times 16\,\mu$ (typical case). The vacuoles in the endosarc vary greatly in size. Large ones, distinct with an a_2 (Zeiss) objective, and often measuring $40\,\mu$ in diameter, are scattered about in some abundance. When the body is compressed, or when sections are examined, the endosarc is seen to be honeycombed with vacuoles of all sizes; the very small ones, a few microns in diameter, being especially abundant. So abundant are the vacuoles in parts of the endosarc that the optical effect (in section or thinly expanded pseudopodium) is that of a spongy reticulum.

There is no contractile vacuole in this form. If a vacuole disappears, it does so simply because of the shifting of the protoplasm. The endosarc contains in the greatest abundance minute crystals, which contribute very materially to its dark appearance with transmitted light. These bodies are of an elongated fusiform shape, about $2\,\mu$ in length. When seen end on, they look like dots. They are readily soluble in alcohol and in dilute acetic (used in acetic carmine and methyl-green solution), but are neither stained nor dissolved by one per cent osmic. Their diminution in size and gradual disappearance, when treated with the above solvents, may be watched under the microscope. It requires but a few minutes for them to vanish completely, leaving the other inclusions much more distinct than they formerly were.

Scattered abundantly through the endosarc are spherical bodies, having in the living animal a bright appearance with a dark contour, and looking much like oil drops. They very commonly have a diameter of about 8 microns, though smaller ones of all sizes are present. These bodies evidently correspond to the "Glanzkörper" originally described by Greef [1] in *P. palustris*, although in the latter form they may reach a much larger size than I have observed in *P. carolinensis*. These "refringent bodies," as Gould [2] calls them, are insoluble in alcohol. They are stained by osmic acid and by iodine (alcoholic solution), in nowise differently from the granules of the endosarc (*i.e.*, are browned). They cannot, therefore, be of a fatty or starchy nature. The contents of the bodies is fluid, as may be demonstrated by allowing the Pelomyxas to be gradually compressed through the slow evaporation of water from under the cover-glass. At a time when the arrangement of the coarser and finer granules of the protoplasm is not interfered with, the globules burst and run together, suggesting fat droplets very strongly, but even in this condition osmic acid does not blacken them. On the other hand, the globules are stained a deep blue with hæmatoxylin. In sections (fixed in Zacharias, stained with Delafield's hæmatoxylin) it may be seen that the endosarc is thickly studded with coarse granules, which stain blue with hæmatoxylin. The smallest refringent bodies, recognizable as such, differ but little in appearance from these coarse granules. They are slightly larger, of a more rounded shape, and take a deeper stain. From these minute globules, all gradations in size may be found up to the large ones, 8 microns in diameter. With the increase in size the depth of coloration increases — an effect due doubtless to the greater diameter. The bodies, when stained with hæmatoxylin, present a perfectly homogeneous appearance. From the evidence at hand, it would seem to me that the bodies are globules of an albuminous nature, consisting of a pellicle, enclosing a more fluid substance. Greef (*loc. cit.*) inclined to the

[1] *Arch. f. mikr. Anat.*, Bd. x, 1874.

[2] Notes on the Minute Structure of Pelomyxa palustris, *Quart. Journ. Micr. Sci.*, vol. xxxvi, 1894.

belief that the "Glanzkörper" were of intranuclear origin, and were concerned in reproduction. Gould (*loc. cit.*), working on *P. palustris*, failed to see evidence for the truth of these ideas, and in the form which I have studied there was no such evidence. Gould found the "Glanzkörper" to have a homogeneous appearance when stained with ordinary stains (the exception does not seem to have any special significance); and she reached the conclusion that they were "almost certainly either solid structures or filled with coagulable fluid." With the latter alternative I agree.

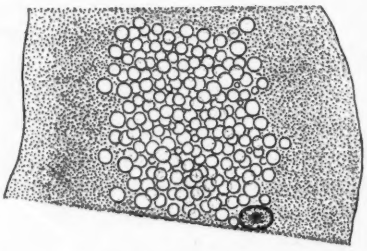

FIG. 10.—Portion of a starved Pelomyxa. Crystals dissolved out with alcohol. Drawn in water. Zeiss *D* × 4. Reduced to 2/3.

The condition of the albuminous globules in starved individuals deserves a word. In healthy, active specimens the globules are scattered all through the endosarc. In certain individuals kept without food in pure water for several weeks, the globules were much more numerous than in normal specimens, and were aggregated together in several regions of the body. In each such region (Fig. 10) the globules were thickly crowded, while elsewhere they were nearly absent. These starved Pelomyxas were about one-third the common size of healthy specimens, and were exceedingly sluggish in movement.

In specimens of Pelomyxa kept without food for some time the body contains no inclusions except such (granules, crystals, albuminous globules) as seem to be normal and constant constituents. Owing to its large size and freedom from foreign inclusions, *P. carolinensis* presents certain marked advantages for the study of the fundamental structure of protoplasm. As a living object it is perhaps no better than smaller rhizopods, though under a cover-glass the pseudopodia may flatten out into very thin sheets. On the other hand, it is easy to handle for sections, and in sections the vacuolar walls in particular are instructive. One of the large vacuoles may be cut into several sections, and will thus afford both true sectional and surface

views of its wall. For comparison with the living animal I have found it useful to employ surface preparations of specimens mounted in glycerine, after killing with acetic carmine or acetic methyl green; or surface preparations of specimens killed in alcohol and mounted in water. Acetic carmine (45 per cent acetic) kills the animal as quickly as an osmic fixative, the outline of the living state being faithfully retained. Alcohol and acetic methyl green kill more slowly, the animal undergoing some change of shape, which involves especially the peripheral region. On addition of these fluids the coarsely granular endosarc either contracts, or the surface film of the Pelomyxa is raised up by absorption of fluid. That the latter is the case, is the impression made on one when the animal is kept under observation during the action of the fixative — the surface seems to rise up often in bleb-like swellings. The result, at any rate, is that the clear ectosarcal region, very narrow in life, is greatly increased in width, and thus a considerable area, exhibiting the fine reticular (alveolar) structure characteristic of this region, may be had for study.

The general endosarc lying between the vacuoles shows the greatest abundance of coarse granules so closely set that they must obscure whatever finer structures are here present. These granules very commonly have a diameter of one micron, though smaller ones of varying size are abundant.

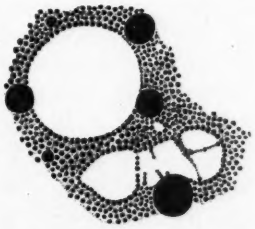

FIG. 11. — Part of section showing vacuoles, deeply stained endosarcal granules, and several deeply stained albuminous globules. Zeiss $\frac{1}{12}$ × 4. Reduced to $\frac{2}{3}$.

In sectional view (Fig. 11) the walls of many of the larger vacuoles seem made up of similar coarse granules, arranged regularly so as to form a smooth bounding surface for the cavity. These bounding granules are generally about 1 μ in diameter, but in places they may be much smaller, ranging down to the size of microsomes. Long vacuoles are occasionally found somewhat constricted, so as to be incompletely divided up into chambers (crenellated vacuoles of Gould, *loc. cit.*), as in Fig. 11. Intravacuolar strands may be seen in these vacuoles. In

some cases the strands are undoubtedly the free edges of folds. Some of the strands consist of a single row of comparatively large granules (intermediate in size between the microsomes and the coarse endosarcal granules), easily counted, and which are connected by the finest lines (fibres), in which no structure can be made out with $\frac{1}{12}$ Zeiss. Other intravacuolar strands are of considerable thickness, appearing as a mass of finest granules (microsomes) closely set, in which a coarse granule is found here and there. Still other strands appear as exceedingly delicate lines, made up of one row of microsomes.

In surface views of vacuolar walls, studied in sections, the same appearance is not always had. In many cases the wall seems made up of microsomes, arranged so as to give in places the appearance of a reticulum, the mesh of which is in the neighborhood of a micron. Interspersed among the microsomes much larger granules are found here and there, connected by fine strands, which often consist of a row of microsomes, though in other cases the connecting strand appears as a homogeneous line. In other vacuoles (always of considerable size) the wall when seen in surface view exhibits coarse granules, set regularly and almost as closely as in the intervacuolar endosarc, between which run fine strands. If microsomes are present in such a wall, their presence is obscured by the coarser reticulum.

The ectosarc in even a thinly expanded pseudopodium looks nearly homogeneous ($\frac{1}{12}$ Zeiss) in the living animal. In acetic carmine preparations mounted in glycerine, and in alcohol or acetic methyl-green preparations mounted in water, the ectosarc may be seen to be occupied by a delicate reticulum, the mesh of which is close to 1 μ. I was not able to decide with certainty (working, however, only with Zeiss $\frac{1}{12}$) whether the microsomes are always situated at the points of intersection of the reticular lines (lamellæ of Bütschli), or whether each (apparently) linear side of a mesh included a short row of microsomes. Dispersed in this delicate reticulum, which seems identical with that seen in many vacuolar walls, are to be found here and there a few coarse granules.

The fine ectosarcal reticulum, in a fixed specimen examined

in water under an unsupported cover, may be seen with a Zeiss $\frac{1}{12}$ to enter into the composition of the surface film. This now appears as a row of microsomes connected by strands. On the other hand, when the Pelomyxa is examined under a supported cover-glass with a dry lens, the superficial membrane has an appreciable thickness and is plainly doubly contoured. Blochmann [1] mentions that in his Pelomyxas the "Hautschicht" seems to have a double contour. The doubly contoured appearance of the surface membrane is, I believe, due to the arrangement of the superficial meshes (alveoli of Bütschli), which, as Bütschli [2] has shown in so many cases, are arranged in a layer with the partition walls vertical to the surface. That is, the membrane appears doubly contoured, because we see the outer and inner walls of the meshes of the superficial layer, and fail to distinguish the partition walls between the several meshes. Under slight pressure the reticular (alveolar) structure comes into view.

In these few notes on the finer structure of the cytoplasm I have used the terms "microsomes" and "reticulum" as indicating the optical appearances obtained, and not with the intention of expressing a belief that the structures as such have an actual existence.

In *P. palustris* the regularly arranged coarse granules, described above as present in vacuolar walls, are not figured by Gould (*loc. cit.*). In *P. carolinensis* they may easily be seen in the living specimen. The regularity of their arrangement at first sight suggests that they are not, to use some apt expressions of Mrs. Andrews,[3] mere "passive chemical inclusions," but are "physiological areas or substance organs," *i.e.*, permanently differentiated portions of the living substance. On the other hand, they are not always present throughout the extent of the vacuolar wall, and in many vacuoles are absent or nearly so. The presumption is thus a fair one that the bodies are mesostates, and owe their regular arrangement (in places) to the underlying fine reticulum.

[1] Kleinere Mittheilungen über Protozoen, *Biol. Centralbl.*, Bd. xiv.
[2] *Investigations on Microscopic Foams and on Protoplasm.*
[3] *The Living Substance*, p. 16. Boston, 1897.

The number, shape, and size of the nuclei have already been alluded to. The chromatin granules are extremely numerous, especially abundant just within the nuclear membrane. They also form a densely crowded large mass in the center of the nucleus. Between the peripheral layer and central mass, the nucleoplasm comes into view more conspicuously than elsewhere. The granules are connected freely by intervening delicate strands, which themselves often show a row of finest granules. The granules, as a whole, are too crowded to permit decision as to whether a continuous reticulum exists. The chromatin granules vary in size from that of the cytoplasmic microsome up to much larger ones, 1 μ in diameter, the size of the common coarse granules in the wall of vacuoles.

Motion. — I regret not to have studied the currents of the body, when the animal is in those shapes in which it is only applied to the surface at isolated points (Figs. 3–7). At such times a locomotory motion, if it existed, escaped my notice. The animal was at rest for sufficiently long periods of time to permit careful study and drawing.

When the body is linear and applied throughout its extent to the surface, as in Figs. 1 and 2, the motion is, in general, similar to that of *P. villosa*,[1] or of the form commonly known as *Amœba limax*. As has already been said, *P. carolinensis*, when placed on the slide, assumes the habitus of *Amœba proteus* (Fig. 8). In this condition the movements are active, the pseudopodia being protruded in, or nearly in, a horizontal plane, but in any direction. The difference in appearance between pseudopodia into which the current is going, and those out of which it is flowing, is in this condition very noticeable. The contour of the former is smooth, the pseudopodia having an appearance of plumpness and distention. In the latter case, on the contrary, the surface is thrown into "mulberry-like" folds at the ends of the pseudopods. Moreover, it can frequently be seen in such a pseudopodium that the upper surface is thrown into longitudinal wrinkles. These are shown in two of the pseudopods in Fig. 8. The appearance of these pseudopodia is in perfect harmony with Bütschli's description (*loc. cit.*,

[1] Leidy. *Fresh-Water Rhizopods of North America*, p. 73.

p. 313) of the backward flow of protoplasm from a pseudopodium : "The viscid external layer cannot flow together rapidly enough to keep pace with this diminution, in consequence of which it is thrown into folds, etc." Returning to the expanding pseudopodium, I may say that Wallich's remarks on *Amœba villosa*, quoted by Leidy (*loc. cit.*, p. 75) as applying to *P. villosa*, aptly describe the appearances to be had in *P. carolinensis*. After the local thickening of ectosarc, which precedes the formation of a pseudopodium, there is a *sudden* inrush of granules. The very suddenness of this inrush inevitably suggests that something in front has burst or given way, rather than that something behind has *begun* to contract, and, as far as it goes, is an argument for Bütschli's theory (*loc. cit.*, p. 311), that the formation of a pseudopodium is primarily due to the bursting of superficial alveoli, whereby (through the action of the enchylema on the free surface of the protoplasm) the surface tension in that locality is diminished.

Systematic. — In the assumption of complexly branched shapes (Figs. 6 and 7) *P. carolinensis* differs from the described conditions of the type species, *P. palustris* Greef, and of *P. villosa* Leidy, which are habitually more or less slug-like when in motion, and of massive shape when at rest. The peculiar posterior "villi" characteristic of the latter form are absent in *P. carolinensis*, which, moreover, differs from both forms in the fact that it does not gorge itself with mud, and that it contains no "Stäbchen" or symbiotic bacteria, as they are believed to be by Gould (*loc. cit.*) and some other observers. The Glanzkörper (albuminous globules) are present in Greef's species, and Leidy describes them in *P. villosa*. Blochmann (*loc. cit.*) and Frenzel (*loc. cit.*), however, mention their absence in the forms which they identified as belonging to *P. villosa*. The minute crystals which I find so abundantly in *P. carolinensis* are apparently not present in *P. palustris*. Neither Greef nor Gould mentions them, nor were they found by Leidy in *P. villosa*. Possibly the granules which Blochmann finds in such quantity in some of his Pelomyxas correspond to my "crystals." The Pelomyxas in which Blochmann finds the granules abundant have large and conspicuous Glanzkörper,

round which the Stäbchen never form a mantle. Blochmann groups these forms under *P. palustris.* Other forms Blochmann unites under the provisional species, *P. greefi*, characterized by the almost complete absence of the granules, and by the small number of Glanzkörper, which are always surrounded by a thick coating of Stäbchen. The peculiar habitus assumed at times, absence of sand in the body, absence of Stäbchen, presence of the crystals, are the distinguishing characteristics of my species against the related forms, *P. palustris*, *P. villosa*, *P. greefi.*

The habitus in rhizopods, however, is undoubtedly a most inconstant feature, readily affected by the individual environment, as may be learned from *P. carolinensis* itself. The interesting observations of Verworn (*Allgemeine Physiologie*, p. 190) on the change of shape in amœbas, through the *A. proteus*, *A. limax*, and *A. radiosa* condition, likewise indicate this. And it seems probable, from the diverse forms of Pelomyxa, that Blochmann (*loc. cit.*) has found that the cytoplasmic inclusions, even the characteristic Glanzkörper, are all inconstant, and are to be looked on as the outcome of the individual environment. A greater familiarity with the four above-mentioned forms may thus show that they all belong to a single species.

UNIVERSITY OF NORTH CAROLINA,
December 18, 1899.

A REMARKABLE AXOLOTL FROM NORTH DAKOTA.

HENRY LESLIE OSBORN.

THE name "axolotl" is primarily the popular designation among the Mexicans for an animal found abundantly in their lakes. The name "siredon" has also been applied to this and allied animals, at first as a generic name, till that was shown to be superfluous by the demonstration of the amblystomid nature of the axolotl, or siredon, larva. The Mexican axolotl is said not to metamorphose from an aquatic to a terrestrial form after the manner of Amblystoma, but to be a permanently aquatic animal, thus imitating Necturus physiologically, with which, however, it has no morphological relationship, as indicated by the fact that Necturus has no free gula folds or opercula, only two gill slits, no dorsal fin, a much shorter tail, and only four toes in the hind limb. It had early been strongly surmised that the axolotls were amblystomas, but Dumeril of Paris in 1865 was the first to observe the metamorphosis of axolotls into true adult amblystomas. Specimens in the Jardin des Plantes laid eggs which in developing did not stop when they reached the form of their axolotl parents, but continued to develop, losing the gills and many other larval features and becoming true terrestrial salamanders. Dumeril's observations were corroborated by Marsh in 1868, by Tegetmeyer in London in 1870, and by Madame Chauvin in 1874. The latter managed to arrange an experiment in which young tadpole larvæ were gradually transferred from an aquatic to a terrestrial environment, resulting in the correlated metamorphosis to the terrestrial form.

While Dumeril, Tegetmeyer, Marsh, and Chauvin have shown that an amphibian with the characters of the Mexican axolotl does metamorphose into a salamander under some conditions, it has not been satisfactorily shown as yet that the

Mexican form does so, for it is contended by Cope ('89) that all of these have been working, not with the Mexican form, or "true axolotl," but with larvæ of *Amblystoma tigrinum*. The latter have been found in several localities in this country. In 1852 Professor S. F. Baird described the external features of a siredon, called by him *Siredon lichenoides*, from Santa Fé Creek, New Mexico, and later, in 1859, the same writer described another, which he called *S. gracilis*, from the Cascade Mountains, near the fortieth parallel of latitude. This writer did not observe the transformation of siredon (though he conjectured it); but in 1868 Professor O. C. Marsh of Yale College collected siredons in a lake in Wyoming, at a level of 7000 feet above the sea, and conveyed them to New Haven, where they transformed into *A. tigrinum*. Tegetmeyer ('70) figures an *S. mexicanus*, which, while in his possession, transformed into an *A. tigrinum*. It appears from his figure to be identical with Baird's *S. lichenoides*. In all these cases, however, it will be noticed that the siredons were not in their normal surroundings, and hence it is not decided whether their transformation takes place in nature or whether they reproduce while still in possession of the larval characteristics. There is a great difference between merely a greatly overgrown true larva, one not yet capable of reproduction, and the condition of the axolotl in which the reproductive organs are matured before the other organs in the other systems have reached the form that they have in adult amblystomas. It is not impossible that both conditions exist, a siredon in which the animal is a true larva not yet matured, and an axolotl in which the animal is at once a larva and a mature form.

In this sense Marsh's specimens would be siredons, and Dumeril's first generation axolotls, and the second siredons. After the matter of this article had been made nearly ready for the press I had my attention called by Dr. T. G. Lee of the Minnesota State University to a collection of about twenty-five specimens of an axolotl which seems to be very similar to Marsh's *S. mavortium*, and which were found by him in an alpine lake in Montana. Dr. Lee has most generously placed all of this material (which is splendidly preserved in formalin)

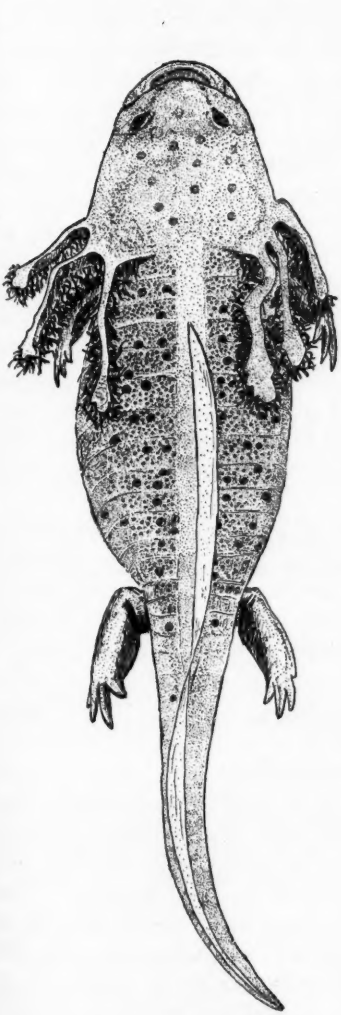

FIG. 1.

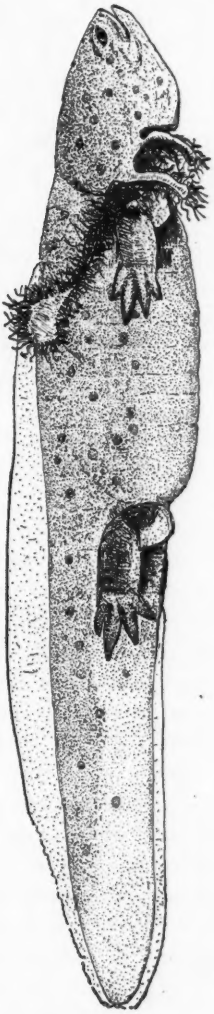

FIG. 2.

FIG. 1. — Dorsal view of Dakota axolotl — one-half natural size.

FIG. 2. — View of right side of Dakota axolotl, one-half natural size; the number of toes in the hind limb here is abnormal and should be five.

at my disposal, and a survey of its contents shows me that, while it is decidedly unlike the axolotl described in this paper, it is suitable for the study of a number of points in the anatomy of the axolotl, on which at present only the most scanty information is in print. I hope to make this material the subject of a second paper, which will follow this one at a later date. I desire in this connection also to express my obligation to Professor L. Stejneger of the U. S. National Museum, and to Professor H. H. Wilder of Smith College, Northampton, Mass., for their suggestions with reference to the bibliography of this subject.

The Dakota specimen shown in dorsal and side views in Figs. 1 and 2 differs from previously known forms, including the Montana ones of Dr. Lee, in a number of anatomical points, and besides it comes from a region that is very different in geographical conditions from all regions previously reported.

It is known by only a single specimen, which was sent to the writer for identification by Miss Prudence Tasker of Amenia, North Dakota. It was found on March 21, 1899, in Rush River, a tributary of the Red River of the North, a situation described by the sender as "called a river merely by courtesy, — a stream that rises in a marsh and ends in a marsh, — dries up every summer, except in little pools." The stream is mostly shallow, but at one place has been made deeper by a dam, and here the specimen was found. The stream contains limited numbers of the smaller kinds of fish. It was found by a workman who had cut a hole in the ice to water horses, and while baling snow out of the hole baled this specimen out with the snow. He was attracted to it by seeing it crawl. It was taken to the store of Mr. Mosberg in Amenia, where it was examined by many persons, none of whom were familiar with anything like it. It died after a few hours and was sent to me packed in snow, and some drawings and measurements were made while it was still fresh.

Since receiving this specimen another has been reported by Miss Tasker; it was found by Mr. G. Makee in June, 1898, at Kenmare, North Dakota, on the bank of Mouse River, in

shallow water. This specimen was seen by Miss Tasker and identified as the same as the one herein described. It measured eight inches in length. These specimens, coming as they do from lower levels and not from alpine localities, and from northern, in contrast with the warmer southern levels of most of the former discoveries, are interesting and hold out some prospects that a study of these creatures in their natural surroundings would throw light on the problem of the relationship of these peculiar larvæ to the amblystomas. The general appearance is shown in the accompanying drawings, which were made from the formalin specimen. The following dimensions were also taken from the specimen after preservation in formalin, but both were compared with the data from the fresh animal:

Chin to tip of tail	312 mm.
" " border of gular fold	35 mm.
" " armpit (posteriorly)	72 mm.
" " center of pelvic arch	159 mm.
" " posterior edge of cloaca	192 mm.
Snout to line joining hinder angle of gills	59 mm.
Greatest height of tail	32 mm.
" thickness of tail	18 mm.
" height of dorsal fin	08 mm.
" diameter of head	55 mm.
Width of mouth	30 mm.
Distance between anterior nares	14 mm.
" " posterior nares	18 mm.
" " centers of eyes	26 mm.
Width of head at eyes	39 mm.
Snout to line joining centers of eyes	13 mm.
Length of filament-bearing border of first gill	45 mm.
" " second gill	53 mm.
" " third gill	69 mm.
" " arm	24 mm.
" " forearm	17 mm.
" " hand	19 mm.
" " thigh	19 mm.
" " fore leg	19 mm.
" " foot	22 mm.

The animal displays a combination of larval and adult characteristics in its exterior form. The main lines are those of

Amblystoma, and many of the proportions are closely similar, and this similarity extends to the internal organs, which are even more like those of the ordinary form of Amblystoma than are the external parts. In point of size it greatly exceeds the average of Amblystoma and goes beyond the maximum reported length by 30 mm. The lengths of fifteen specimens, taken from a collection made at St. Paul, of *A. tigrinum* are as follows: 122, 128, 134, 140, 151, 160, 165, 165, 167, 170, 185, 187, 200, 204, 220 millimeters. The Dakota specimen is almost 100 mm. longer than the longest of these and much more considerably exceeds their average. Cope ('89) reports a specimen of 250 mm. from Wisconsin, and quotes De Kay for another of 280 mm. The Dakota specimen thus exceeds the recorded maximum length of Amblystoma by over one inch. A special detailed comparison of the dimensions of the separate organs will be made in connection with each of them, and we may pass at once to a survey of them in succession.

There is a considerable difference between the Dakota specimen and the adult amblystomas in the character of the skin, both as to coloration and as to the character of the surface. As to the former point in this axolotl the general color is dark livid blue, with a lighter area in the middle dorsal region, instead of the jet-black color found dorsally everywhere in *A. tigrinum*. On this ground are occasional large circular dark spots. This coloration is in marked contrast with adult *A. tigrinum*, where we find bright yellow spots of a great variety of irregular shapes, often elongate and confluent, and with either *S. mexicanum* or *S. lichenoides*. In the former "a pinkish gray ground is covered with numerous small, round, dusky spots rather closely placed" (Cope, '65, '89), and in the latter the ground color is blackish brown, with irregular patches of grayish yellow, "reminding one of the growth of lichens" (Baird and Girard, '52, p. 336), much as in the adult form of *A. tigrinum;* while in Baird's *S. gracilis* the body is marked with very small and numerous dark spots that give it a decidedly mottled appearance.

In addition to this difference in coloration the skin of the Dakota form differs from the texture of the adult and, as far

as I can tell from figures, from that of the other larval forms. It is not smooth, but is somewhat coarse and warty-roughened, generally on the back and sides; but this condition is replaced on either side of the dorsal fin by a narrow area in which the skin is entirely smooth. This difference in texture is noticeable. It is not shown in Baird's figures, but it is possibly indicated in Marsh's, so that it may exist in some stages, at any rate, of their forms.

The head in the Dakota form and in all the siredons is quite different from that of the adult *A. tigrinum*. Dorsally it is flattened as in *A. tigrinum*, but ventrally it is swollen and rounded so as to present in a side view a very different appearance; this difference is directly correlated with the presence of the branchial apparatus. The whole head, however, is relatively larger here (and in the Montana form) than in the adult *A. tigrinum*. The measurement of the length of head is made from the line connecting the posterior boundary of the gill; the location of this is still visible as a rudiment in the adult, and thus furnishes a very constant point from which to measure. For comparison with this I have taken the distance to the hinder boundary of the cloaca, which gives the length of the trunk, to compare with that of the head, as being more accurate than to take the total length. There is some variation in the sizes of all these regions, and by taking the head and comparing it with the trunk the influence of variation is less than it would be if the two regions of trunk and post-abdomen were both taken.

The length of the head in the Dakota specimen is 31 per cent of the length of head and trunk together. This is relatively larger than the head of *A. tigrinum* in the larger sizes of the species. Thus it is found in a series of twelve specimens that the length of head ranges from 31 per cent of head and trunk, in the shortest cases, to 25 per cent in the longest ones. If this ratio were followed out, the length of head for a specimen 312 mm. in length would be only 20 per cent of head and trunk, in contrast with 31 per cent as here. This point of size of head shows even more distinctly in Dr. Lee's Montana forms than in this one from Dakota, for there the range is

between 38 per cent and 30 per cent, in all cases about 5 per cent greater than for adults of *A. tigrinum* of the same total length. The distance between the centers of the eyes is less than in the adult Amblystoma, where the eyes, instead of being located considerably inside of the margin of the face, are lateral. The area of the face, in front of the line connecting the centers of the eyes, is also less than in the adult. In the latter the distance from the snout to this line is generally about one-third of the length of the head, while in the Dakota form it is one-fifth. The diameter of the mouth opening, too, is less than in the adult of *A. tigrinum*, in that the angle of the mouth coincides with the angle of the jaw; in other words, there are no developments of free skin, forming lips or cheeks, and the angle of the mouth is located directly under the eyes; but here, while the angle of the jaws is beneath the eyes, there are folds of skin forming lips and a sort of cheek cavity, so that the angle of the mouth lies anterior to the level of the eyes.

FIG. 3. — Ventral view of throat and jaw of right side of Dakota axolotl, with the gular fold (*g.f.*) turned forward so as to expose the gill slits (*g.s.*), gill rakers, and four opercula (*o.p.*). × ⅓.

On the under side of the front part of the head there is a transverse fold of skin, "gular fold," which is attached in front and free behind, where it overlaps the gill slits and bases of the gills. This fold is entire in the middle line, as seen in Fig. 3, in contrast with its decidedly emarginate outline, as seen in Baird's figures ('59, Figs. 1 *d*, 2 *c*) and in the Montana specimens.[1] The gular fold covers and hides four gill slits. The first one is directly behind it and in front of the first of the four gill arches. It differs from the other three slits by the absence of denticulations of the skin, reinforced by cartilage, and reminding one of the gill rakers of the sturgeon, which guard the passage through the other three slits. The arches are supported by a rod of cartilage which arches around

[1] But not in Baird, '52.

from the hyoid bone to the roof of the skull. The skin below the arches forms a thin flap, the operculum, which is continuous at its outer edge with the gill, a fleshy outgrowth running outward and backward. The gills are compressed at the base so as to be flattened vertically; but this decreases as you pass out on the gill, till at the tip it is flattened from above and considerably widened to a spatulate form. They are of different lengths, increasing as they go back, and the longest is considerably longer than the head. In all other forms they are no longer than the head, and in most they are decidedly shorter. And in all other forms they are lanceolate in outline and taper acutely at the tip.

The gills bear a tangled mass on the under side, or at the margins in the flattened distal part, composed of a great number of jet-black, long, and slender filaments, some of which attain a length of 11 mm. The filaments are actually much more numerous than is shown in the figures, forming an indiscriminate mass of hairy appearance all down the edge of each gill. These filaments, again, are unlike those of other forms. Thus in *S. gracilis* of Baird ('59) the filaments are broad, flat, short, and straight; here they are slightly flattened, but are extremely long and slender. In the Montana specimens these structures are more suitably indicated by the term "plates" and are 1 mm. wide by only 3 mm. long.

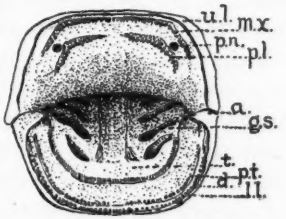

FIG. 4. — Mouth and throat chamber of Dakota axolotl — *a.*, angle of jaws; *d.*, dentary; *g. s.*, gill-arch; *ll.*, lower lip; *mx.*, maxillary teeth; *pl.*, palatine teeth; *p.n.*, posterior nares; *p.t.*, posterior row of teeth of lower jaw; *u.l.*, upper lip. × ½.

The mouth cavity is illustrated in Fig. 4. There are thin, slightly fleshy upper and lower lips. Directly behind the upper lip is a bony arch, bearing a limited number of small teeth, *mx.*, which are set close together and crowded so as to form, somewhat indefinitely, two rows. This arch is relatively much shorter than it is in the adult *A. tigrinum*, where the row of maxillary teeth reaches back nearly to the angle of the jaw, and very considerably posterior to the level of the posterior

nares. The palatine teeth are numerous and evident, and there is a decided bend in the palatine bones, in marked contrast with the feebler development of teeth in the adult *A. tigrinum*, where also the palatines are not so strongly bent as here. In the lower jaw the dentary also bears an indistinctly double row of well-marked teeth, and directly behind it there is another row of teeth (splenial?), carried on a bony or cartilaginous support, which appears to be entirely distinct from the dentary, though in close relation with it. The posterior row is not complete in the middle line. The floor of the mouth is pierced by the gill slits, and the tongue is only feebly developed.

The trunk region is somewhat distended by the reproductive organs. Its wall is marked by the "costal grooves," as they are called by Cope ('89), consisting of light, narrow myocommata and darker broad myomeres. The number of myomeres included between the front and hind limbs is twelve, as in *A. tigrinum*. The proportion of the trunk to the post-abdomen is the same as in the adult *A. tigrinum*. The dorsal fin originates on the level of the second costal ring, some distance behind the head. The position of this point of origin in the Mexican axolotl and in Baird's siredons, as indicated in the figure in Stansbury's report, is close to the head, but in Tegetmeyer's figure and in the specimens from Montana the fin originates as in the Dakota specimen. The fin is not very high at any point, and in texture is not thin; in the Montana specimens the fin broadens out very much in the post-abdominal region, more so than in any other recorded forms, and is very thin, so that the branchings of the blood vessels are very evident.

The limbs are located here as usual, but the fore limb is shorter than in some of the allied forms, reaching only to the sixth myomere, while in the Montana axolotls I find that they reach the eighth myomere. The fingers are considerably flattened, and at their base the skin stretches across between them so as to produce a web; this result is further aided by the very broad and slightly flattened condition of the forearm. The same condition is noticeable in the hind limb. In the latter the typical number of toes, *viz.*, five, is found on the left side, but only four are present on the right; this number is abnormal.

The "tail," or post-abdomen, is compressed, and it is considerably less in cross-section than the trunk; this disparity is greater here than in adults. Its outline is unlike that of other axolotls and of the adult *A. tigrinum;* in them it gently tapers from the base; here it is almost parallel-sided till the tip is nearly reached, when the taper is rapid. In this point the tail is decidedly different from the Montana forms.

A complete dissection of the viscera has not been made, but enough has been seen by cutting through the body wall and pushing the parts aside to show that the organs generally are as in the adult salamander. This was seen to be true of the alimentary organs, the lungs, and the urogenital system. The lungs are fully developed on both sides. The specimen is a female, and the ovaries are fully ripe and contain the usual vast number of eggs, each having a diameter of about 2 mm. The oviducts are greatly twisted and dilated with albuminous material to be used in egg laying. These organs both agree in appearance with adult females of *A. tigrinum*, ready for spawning, which have been often met in the laboratory. The maturity of these organs and the simultaneous larval condition of so many other parts are convincing proof that the specimen is a true axolotl. It is not credible that the animal could have undergone transformation of its other parts before the eggs should have been laid.

The spawning season for Amblystoma is very early in the spring; often the spawn is found in the ponds while they are still frozen in places, and this specimen caught in the last of March was just in readiness for the spawning act. It is interesting to note here that some of the specimens from Montana are also in a condition of activity of the reproductive organs, as is shown by the recognition of Spermatozoa in the males, and ripe ova in the females. These facts are the only ones on record, so far as I am aware, going to prove that the American forms are like the Mexican axolotl, and in their native state reproduce while still larval in form.

Since this specimen is the only one of which we have any knowledge, it seems premature to speculate on its significance in connection with the axolotl question, and I have

intended at present only to record the facts about it. These, in brief, are a close general resemblance to *A. tigrinum;* a decided unlikeness to the hitherto recorded siredon larvæ of that species in the following particulars: the total size of the specimen, the shape of the gular fold, the size and shape of the gills, the number, size, and shape of the gill filaments, the proximity of the eyes to the snout, the coloration of the body, the length of the front limbs, the outline of the post-abdomen, the locality in which it is found. This decided divergence calls for a more complete study of the Amblystomidæ of that region, and this it is hoped will be made during the coming season.

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ST. PAUL, MINN., Feb. 3, 1900.

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THE FEMALE OF ECITON SUMICHRASTI NORTON, WITH SOME NOTES ON THE HABITS OF TEXAN ECITONS.[1]

WILLIAM MORTON WHEELER.

One of the most interesting problems confronting the student of ant life in subtropical and tropical America is the determination of the sexual forms of the foraging, or driver, ants (Ecitonini). These ants are known only from a study of the workers, as the corresponding male and female forms, which are so aberrant as to have been placed in different genera, have not been satisfactorily determined in any one of the known species. The state of our knowledge of the sexes of the Dorylides (including the African species of Dorylini) up to 1899 is summarized by Sharp in the *Cambridge Natural History*[2] as follows:

> The females of the Dorylides are amongst the rarest of insects and are also amongst the greatest of natural curiosities. Although worker and female ants are merely forms of one sex, — the female, — yet in this subfamily of ants they have become so totally different from one another in size, form, structure, and habits that it is difficult to persuade one's self they can possibly issue from similar eggs. In the insect world there are but few cases in which males differ from females so greatly as the workers of Dorylides do from the females, the phenomena finding their only parallel in the soldiers and females of termites; the mode in which the difference is introduced into the life of the individuals of one sex is unknown. . . .
>
> The specimens of female Dorylides that have been detected may, after fifty or sixty years of research, be counted on the fingers. As the greatest confusion exists in entomological literature owing to the forms of a single species having been described as two or three genera, the following summary of the principal names of genera of Dorylides may be useful:
>
> *Eciton* = the workers; *Labidus* = male; ♀ unknown.
> *Pseudodichthadia;* female only known, possibly that of *Eciton*.
> *Cheliomyrmex;* workers and soldiers only known.

[1] *Contributions from the Zoölogical Laboratory of the University of Texas.* Director W. M. Wheeler, No. 4.

[2] Vol. vi, pp. 179, 180.

Aenictus = male; *Typhlatta* = worker; ♀ unknown.
Rhogmus; male; female unknown (according to Emery the worker is very small and like *Alaopone*).
Anomma; only worker known; male probably a *Dorylus*.
Dorylus = male; *Dichthadia* = ♀; *Alaopone* and *Typhlopone* = workers.

Until last year the only known insect that could be regarded as a female Eciton was the Pseudodichthadia, included in the above table. It was described by André as *P. incerta* in a paper which I have not seen. It has been supposed to be the female of *Eciton omnivorum* Ol (= *cæcum* Latr.),[1] "but his description and figure are imperfect and do not greatly support his idea of a connection between Eciton and Pseudodichthadia."[2]

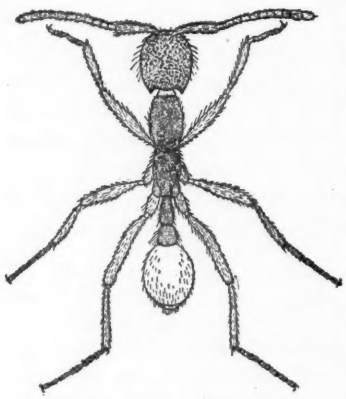

FIG. 1. — Sterile female, or worker, of *Eciton sumichrasti* Norton (length 4.5 mm.).

Professor Forel, while on a visit to the United States during the summer of 1899, discovered in North Carolina what is undoubtedly the female of *Eciton carolinense* Emery. He has drawn up a good description of the insect, but without a figure, in a letter to the Belgian Entomological Society.[3] In this article and in a paper by Wasmann[4] I find mention of the fact that Schmitt had previously (1894) taken this insect in the same region.

For some months past I have been engaged in a study of the nests of the species of ants which abound in the vicinity of Austin, Texas, the locality of the classical studies of McCook

[1] According to Emery (Beiträge zur Kenntnis der nordamerikanischen Ameisenfauna, *Zool. Jahrb.*, Abth. f. System, etc., Bd. viii, p. 258) the male of this form is *Labidus latreillei* Jurine (= *L. Sayi* Haldem).

[2] Sharp. *Loc. cit.*, p. 117.

[3] *Ann. de la Soc. Entomol. de Belgique*, tome xliii (1899), pp. 438–447.

[4] Ein neuer Gast von Eciton carolinense, *Deutsche Entomol. Zeitschr.*, Heft ii (1899), pp. 409, 410.

on the agricultural ant (*Pogonomyrmex barbatus* Smith). I had found several nests of *Eciton omnivorum* and *E. sumichrasti* under stones along the sloping banks of Shoal Creek, but in no case did these colonies comprise anything but workers, till quite unexpectedly, on the 30th of March, in a large nest of the latter species, I detected what may be described in words borrowed from Forel's description of the female of *E. carolinense:* "une longue et large bête aveugle et aptère, se mouvant lourdement avec son immense abdomen distendu au milieu des ♀." There could be no doubt that I had found the queen of the colony.

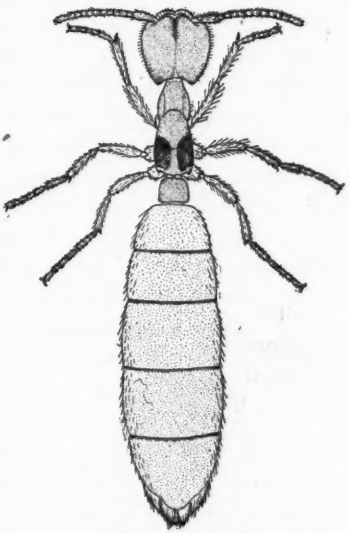

FIG. 2. — Young fertile female, or queen, of *Eciton sumichrasti* Norton.

A few days later (April 11) one of my students succeeded in finding another large nest of *E. sumichrasti* containing an even larger female. In this nest some of the workers were carrying larvæ and pupæ, and the queen was still producing eggs. As this female differs in several particulars from the first one captured, I insert brief descriptions of both, designating the former specimen as ♀*A*, the latter as ♀*B*. Both of these insects had the head and thorax more or less concealed by shining yellow mites, shaped like minute chelomorph beetles, with long yellow hairs projecting from their dorsal surfaces. These mites, represented *in situ* in the sketch of ♀*B* (Fig. 3), were sometimes either rapidly removed by the workers enveloping the queen or migrated of their own accord to the workers. I infer this from the fact that the queen would sometimes emerge from the swarm of workers glistening with these parasites, while at other times she would be found entirely free from them.

♀*A*. Length 13.5 mm. Light reddish brown, articulations of antennæ and legs and a large oblong blotch on either side of the metanotum, extending over the posterior third of the mesonotum, black. Surface of head, thorax, and abdominal pedicel subopaque, coarsely and rather densely punctate. Abdomen and legs shining, more finely and sparsely punctate. Body covered with delicate golden-yellow hairs, long on the legs and on the sides and tip of the abdomen, short and erect on the head.

Head large, swollen, subcordate above the clypeus, broader in front than behind; posterior angles rather prominent, but not acute as in the worker. Eyes vestigial like those of the ☿; ocelli absent. Mandibles slender, pointed, without distinct teeth. Down the middle of the head from the clypeus to the occiput runs a distinct furrow, deepest anteriorly. Antennal scape short, incrassated; funicle consisting of subequal joints, except the last, which is twice as long as any of the preceding. Legs short, tibiæ and femora compressed antero-posteriorly. Thorax slender, elongate, without any traces of wings; suture between the pronotum and mesonotum faint but distinct, metanotum broader than the mesonotum, both flattened dorsally and distinctly impressed along the median line. Posterior surface of thorax declivous, bearing on each side near its lower posterior corner a small but distinct tooth. Abdominal pedicel consisting of a single node which is nearly square, being somewhat broader than long, with its anterior somewhat shorter than its posterior edge, flattened dorsally and with a slight longitudinal impression in the median line.

♀*B*. Length 17 mm. Dark rufous brown, legs somewhat lighter, black spots on the metanotum inconspicuous, with indistinct contours. Surface of the head, thorax, and abdominal pedicel more coarsely and confluently punctate than in ♀*A*; the mesothorax somewhat transversely wrinkled.

Head proportionally smaller than in ♀*A*. Furrow down the middle of the mesonotum and metanotum and the abdominal pedicel much deeper. Abdomen with the exception of the first segment greatly enlarged, so that the dorsal and ventral sclerites are separated from one another by the tense interscleritic membrane. This is thin and transparent, but appears milk-white owing to the underlying eggs.

The differences between ♀*A* and ♀*B* seem to be due to a difference in age, the former being a young queen, — possibly not more than a year old, — the latter a much older individual. If this supposition is correct, and if the differences above noted are constant, it is probable that the ♀ Eciton exhibits a certain amount of postmetamorphic growth even in the thoracic and basal abdominal regions.

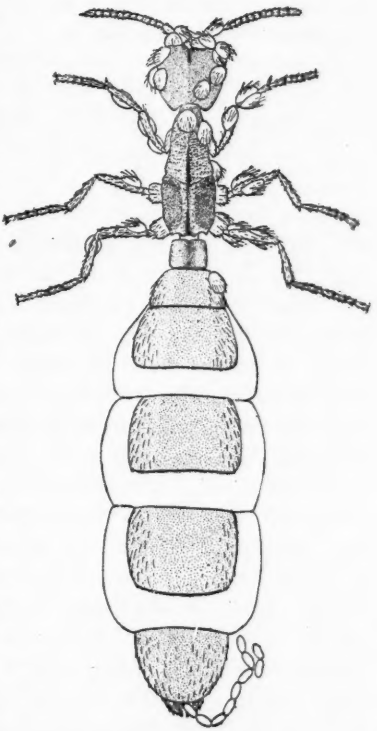

FIG. 3. — Old fertile female, or queen, of *Eciton sumichrasti* Norton, infested with mites. The insect was sketched during oviposition.

The similarity of the ♀ Eciton to the African Dichthadia, the reputed female of Dorylus, will be apparent to any one who compares the accompanying figures with Emery's figure of Dichthadia.[1] I also give a figure (Fig. 1) of the worker of *E. sumichrasti* for the sake of showing the remarkable differences between the fertile and sterile forms of the same sex. The single node in the abdominal pedicel of the female and the two nodes in the worker, characters which are often used in the taxonomic separation of whole families of ants, are here combined, not only in the same species, but in the same sex![2]

[1] Reproduced in Sharp's contribution to the *Cambridge Natural History*, vol. vi, p. 178, Fig. 79.

[2] The discovery of a single node in the pedicel of the female Eciton strengthens the already strong probability that Labidus, also with a single node, is the *bona fide* male of this genus.

The complete absence of any traces of wings in the female Dorylides also suggests many interesting problems for future investigation. The females must be fertilized either within the nest or during the organized marauding expeditions so characteristic of these ants.

Both the females in my possession were introduced at different times into an artificial nest (Janet pattern) of workers taken from an entirely different locality on Shoal Creek. They were very eagerly adopted and at once began to lay eggs. Female *A* laid very few, but ♀*B*, as was to be expected, produced a great number. Some of the workers were always clinging, with signs of great agitation, to the tip of her abdomen, and as soon as an egg would appear on the shovel-like hypopygium it would be seized and carried to another part of the nest. To this same spot other eggs were brought for some time. Later, however, they were distributed in little packets and carried continually in the mandibles of the workers as these marched round and round the nest in files, two and three abreast. The eggs are of the same shape and color as those of *Formica fusca*, but smaller.

During the past year I have seen three species of Eciton in the vicinity of Austin: *E. omnivorum* Ol (= *cæcum* Latr.), *E. sumichrasti* Norton, and what I take to be *E. californicum* Mayr. The last was taken only once by one of my students. Small colonies of *E. omnivorum* are not uncommon under stones, where they make burrows about a centimeter in diameter, usually leading directly into the ground. When the stone is lifted the ants show the greatest presence of mind (*sit venia verbo!*). They do not run about aimlessly and in disorder like other ants, but, notwithstanding the fact that they are absolutely blind, they at once organize themselves into columns and file down their burrows. The habits of this species thus appear to be the same as those of *E. carolinense* recently described by Forel (*loc. cit.*, p. 444):

Leur faculté instinctive de se concerter et de former des files dépasse absolument tout ce que j'ai vu chez d'autres fourmis. Vous jetez une poignée d'Eciton avec leur larves sur un terrain absolument étranger. En pareille circonstance, où les autres fourmis s'éparpillent en désordre et ont besoin

d'une heure ou plus (parfois moins) pour arriver à l'ordre, à réunir leur nymphes et surtout à reconnaître les environs, les Eciton se concertent, sans perdre une minute. En cinq minutes, ils ont formé des files distinctes de ☿ qui ne s'écartent pas les unes des autres, portent en partie les larves et les nymphes, et marchent en ligne assez précise, tâtant le terrain de leurs antennes, explorant tous les trous et fentes jusqu'à ce qu'elles trouvent une cavité à leur convenance. Alors le déménagement s'exécute avec un ordre et une rapidité étonnants. Les ☿ se suivent et se comprennent, comme par mot d'ordre, et en bien peu de temps tout est en lieu sûr. Pas question de transport mutuel ; c'est en plus précis le système des Tapinoma. Le fait est remarquable chez une fourmi aveugle, qui n'a absolument que ses antennes pour se diriger.

The colonies of *E. sumichrasti* are very much larger than those of *E. omnivorum*, and consist of thousands of individuals. They are found under large stones, often occupying cavities which they seem to dig themselves. They assemble in these cavities in compact masses, or swarms, which may be as large as a man's fist. These masses present a peculiar appearance, owing to the interlacing of the innumerable long, dark-red legs and antennæ, interspersed with the shining, lighter red abdomens. If such a mass be hastily scooped up and placed in a glass jar, the method of swarm formation may be watched at one's leisure. If the jar be held perpendicularly after being violently shaken till all the ants fall to the bottom, they will at once proceed to march up the sides of the jar in regular files. A few ants will soon come to rest, clinging to the glass, and will form the nucleus of a swarm which grows rapidly by additions from the moving columns. The ants are positively geotropic and therefore tend to hang head downwards when they cluster on one another. Such a swarm on the side of a jar is usually spindle-shaped, with perpendicular long axis. Frequently the swarm grows too large to be held in place by the claws of the individuals next to the glass, and the whole mass falls writhing to the bottom of the jar. The ants at once file up the walls of the jar and repeat the process. Occasionally the ants arriving at the top of the jar first will form the starting point for chains or festoons of ants, depending sometimes to a length of six inches in the form of a cord about a centimeter in diameter. In forming these chains, which remind

one of the pictures of prehensile-tailed monkeys crossing a stream, the insects make good use of their long legs and hooked claws. These chains may persist for hours, but are more often soon broken as their weight increases. If some loose earth be placed in the bottom of the jar, the ants will be seen to carry little pellets of it in their mandibles as they file up the sides of the vessel and to use these as points of attachment for their feet and jaws during swarm formation. Termites placed in the jar are at once devoured. Their heads and other fragments of their bodies are afterwards used by the ants for the same purpose as the pellets of earth.

It is evident that *E. sumichrasti* possesses in a very marked degree the power of swarming so characteristic of certain tropical Ecitons. The nomadic habits which have been observed in these forms were not observed in *E. sumichrasti*. During the winter and spring months, at least, the Ecitons I have observed occupy the same nest. This they probably continue to do till their young are raised. Belt has given an interesting description of the wandering and swarming habits of *E. hamatum* in Nicaragua.[1]

> The Ecitons are singular amongst the ants in this respect, that they have no fixed habitations, but move on from one place to another, as they exhaust the hunting grounds around them. I think *Eciton hamata* does not stay more than four or five days in one place. I have sometimes come across the migratory columns. They may easily be known by all the common workers moving in one direction, many of them carrying the larvæ and pupæ carefully in their jaws. Here and there one of the light-colored officers moves backward and forward directing the columns. Such a column is of enormous length, and contains many thousands if not millions of individuals. I have sometimes followed them up for two or three hundred yards without getting to the end.
>
> They make their temporary habitations in hollow trees, and sometimes underneath large fallen trunks that offer suitable hollows. A nest that I came across in the latter situation was open at one side. The ants were clustered together in a dense mass, like a great swarm of bees, hanging from the roof, but reaching to the ground below. Their innumerable long legs looked like brown threads binding together the mass, which must have been at least a cubic yard in bulk, and contained hundreds of thousands of individuals, although many columns were outside, some bringing in

[1] *The Naturalist in Nicaragua*, pp. 24–26. London, 1888.

the pupæ of ants, others the legs and dissected bodies of various insects. I was surprised to see in this living nest tubular passages leading down to the center of the mass kept open just as if it had been formed of inorganic materials. Down these holes the ants who were bringing in booty passed with their prey. I thrust a long stick down to the center of the cluster, and brought out clinging to it many ants holding larvæ and pupæ, which probably were kept warm by the crowding together of the ants.

The workers of the Texan species of Eciton have a very disagreeable odor unlike that of other ants. It closely resembles the vile odor of the neuropteron Chrysopa. The females of *E. sumichrasti*, on the contrary, have a mild, pleasant odor.

The males of Eciton, formerly described as species of Labidus, are frequently taken about the electric lights in dwellings and in the streets of Austin. I have seen three species, but two of these, from their size and coloration, can hardly belong to any of the above-mentioned species of Eciton, so that the workers of at least two more species have not yet been found in this vicinity.[1]

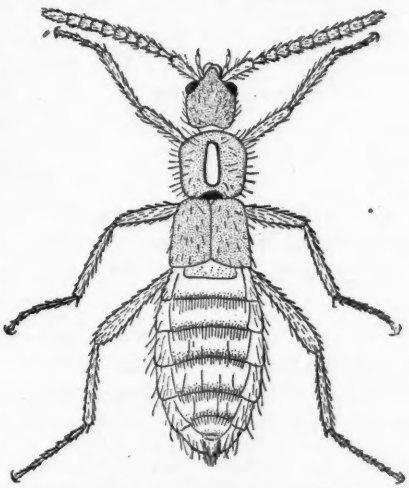

FIG. 4. — Ecitophilous staphylinid beetle occurring in the nest of *Eciton sumichrasti* Norton.

In conclusion some mention may be made of a few myrmecophiles encountered in the nests of Eciton. With *E. omnivorum* occurred a few specimens of a small histerid beetle (presumably *Echinodes setiger* Lec.). The peculiar ectoparasitic mite referred to above may also be included among the ecitophiles. Of greater interest is a small staphylinid beetle (Fig. 4), 2.75 mm.

[1] Cresson (Synopsis of the Hymenoptera of America, North of Mexico, *Trans. Amer. Ent. Soc.*, Suppl. Vol., Phila. (1887), p. 259) enumerates six species of Labidus as occurring in Texas. If these are really distinct species, there must be at least an equal number of species of Eciton in the State.

long, which is so much like a small worker, *Eciton sumichrasti*, that I did not notice it in the artificial nest till the ants had been under my observation for a month! One morning I happened to see it as it was marching around the nest in the files of the Ecitons. The movements of its legs and antennæ were precisely like that of its hosts. This resemblance extends also to its size, coloration, and the character of the surface of its body. Its head, thorax, and elytra are opaque, dark red, rather irregularly punctate, and furnished with a few scattered hairs. The abdomen is smooth and shining, of a lighter red color, widened towards the tip, and covered with longer, denser hairs than the remainder of the body. The eyes are well developed. The antennæ show a decided resemblance to those of the ant. The most striking character, however, is a very deep, elongate elliptical depression in the middle of the pronotum. The bottom of this depression seems to be formed by a white membrane. It is difficult to assign a function to this singular structure, unless it be the orifice of a huge gland that may secrete some substance relished by the Ecitons. During life the broadened tip of the shining red abdomen is bent up after the manner of staphylinids, and the resemblance of the insect to a worker Eciton becomes even more striking.

Wasmann has given an excellent account of the ecitophilous Staphylinidæ of Brazil.[1] In two more recent papers he describes a couple of staphylinids living with *Eciton carolinense*.[2] In his former contribution Wasmann distinguishes a number of ecitophilous genera (Ecitomorpha, Ecitonides, Mimeciton, Ecitonilla), which comprise some very remarkable mimics of the Ecitons with which they live. The form taken by myself is probably the representative of a new genus and is an additional case of mimetic adaptation somewhat less perfect than the genera described by Wasmann. It is, nevertheless, an admi-

[1] Die Ameisen- und Termitengäste von Brasilien, I. Theil, *Verh. k. k. Zool. Zoot. Gesell. Wien.* (Jahrg. 1895) pp. 1–45, 7 Abbild.

[2] Ein neuer Ecitongast aus Nord-Carolina, *Deutsche Entomol. Zeitschr.* (1897), Heft ii, pp. 280–282; and Ein neuer Gast von Eciton carolinense, *Deutsche Entomol. Zeitschr.* (1899), Heft ii, pp. 409, 410. The species are Ecitonusa Schmitti, Wasm. und E. Foreli, Wasm.

rable illustration of the truth of some of Wasmann's remarks concerning these cases of mimicry. Since the Ecitons are blind, the color of the ecitophiles is of no consequence and may differ from that of the ants, — although in the present case there is great similarity even in coloration, — but the form and surface sculpture of the guest insect are of the greatest importance. Wasmann believes that the resemblance in sculpture between the staphylinids and their hosts — rough beetles living with the opaque species of Eciton, and smooth beetles with shining species of the ant — enables the former to prey on the eggs and larvæ of the Ecitons or to share their booty without being suspected as aliens. It is, indeed, quite probable that we have here a new and elsewhere unknown form of mimicry — a deception of the sense of touch which must be extraordinarily keen in these blind ants.

THE UNIVERSITY OF TEXAS,
AUSTIN, April 5, 1900.

POSTSCRIPT.

Since the above account was written it has been possible to make a few additional observations of interest on our Texan Ecitons. The insect which I designated as ♀ *B* died May 18, apparently of exhaustion, after depositing nearly all her eggs. ♀ *A* continued to live in the nest and to produce a few eggs from time to time. On April 20, when I disturbed the clustered workers, I was dumfounded to find them covering also another queen intermediate in length and coloration between ♀ *A* and ♀ *B*! Now this queen, which may be called ♀ *C*, could not possibly have existed as an insect larger than the largest workers (4.5 mm. long) among the thousand or more collected and placed in the artificial nest March 10. Soon after the colony was taken it was kept for about two weeks in a glass jar and had been the subject of numerous experiments on the clustering habit. A large insect, 16 mm. long and with shining white bands on the abdomen, could not have escaped my attention like the small mimetic ecitophile above described. Her presence in the colony can only be explained on the assumption that she was developed within the nest during less than a month from an insect closely resembling a worker in size and appearance. The workers must have been feeding her abundantly, notwithstanding their

devotion to the two introduced queens. Careful comparison of the largest workers with the ♀ of *E. sumichrasti* will show that there is nothing transcending the possibilities of insect development in supposing that a worker could be developed into a queen. This could, perhaps, be accomplished by a certain amount of postmetamorphic growth with an ecdysis or two, but the differences are still too great to justify us in drawing this conclusion from circumstantial evidence. During the coming year it may be possible to solve this interesting problem suggested by the sudden appearance of ♀ *C* in an artificial nest.

In the beginning of May my artificial colony showed signs of demoralization and decay. The eggs laid by ♀ *A* and ♀ *B* had been devoured and the workers were dying rapidly. ♀ *A* and ♀ *C* were killed and preserved May 12, as I had no hopes of raising the males.

Very recently I have succeeded in finding several colonies of *Eciton omnivorum*. One of these, discovered under some large stones May 4, was very large and flourishing, but it contained no queen, larvæ, or pupæ. There were, however, dozens of callow workers of different sizes. This may serve as a clue to finding the still unknown ♀ of this widely distributed species, since it indicates that the breeding season is earlier than that of *E. sumichrasti* — possibly in December or January.

E. sumichrasti was observed on the march May 1. May 2 I saw a black Eciton (near *E. Californicum*, but probably undescribed) moving along a path in double and triple files. These dates are here recorded because they seem to indicate the time when the Ecitons leave their temporary winter quarters to resume their marauding expeditions.

AUSTIN, May 20, 1900.

ON THE LINNÆAN GENERA MYRMECOPHAGA AND DIDELPHIS.

JAMES A. G. REHN.

I. MYRMECOPHAGA.

IN the tenth edition of the *Systema Naturæ*, Linnæus describes three species under the generic name Myrmecophaga, *i.e.*, Didactyla, Tridactyla, and Tetradactyla. Of these three, two have since been placed in new genera: Didactyla in Cyclopes (1821), and Tetradactyla in Uroleptes (1830).

The remaining species, Tridactyla, is characterized as having three toes on the manus and four on the pes, and two pectoral and six abdominal mammæ.

The plates referred to in Seba's work are not identifiable, but the reference of Ray's (*Quad.*, p. 241) quoted refers to the great ant-bear, and it states positively that the animal in question had four toes on the manus.[1] The latter part of the Linnæan description seems to refer to the great ant-bear, except the statement that it climbs trees. The habitat is *America meridionali.*

This name is thus seen to cover a composite animal, one combining some points of the great ant-bear, and the Tamandua (there described as *M. tetradactyla*), with a number of digits and mammæ present in none of the group of ant-eaters, and it should be thrown out of consideration.

The type of the genus Myrmecophaga is, therefore, by elimination *M. tetradactyla*, Didactyla having been separated nine years before.

In the twelfth edition Linnæus recognizes four species of this genus — *M. didactyla*, *M. tridactyla*, *M. jubata*, and *M. tetradactyla*. *M. jubata* possesses a short description, with sev-

[1] This Linnæus seems to have noticed later, and in the twelfth edition he transferred this reference from Tridactyla to Jubata.

eral references[1] which relate pointedly to the large, bear-like, bushy-tailed ant-eater, popularly known as the great ant-bear or great ant-eater. The habitat given is *Brasilia, Cap. b. spei.* The description of *M. tridactyla* in this edition is enlarged, and brings in more points belonging to *M. jubata*, but it retains all its old references but one, and includes two more — Brisson's *Quad.*, p. 27, and Bout. *Java*, p. 320, the latter of which I cannot examine. Brisson's description shows us the same beast of mixed character as above. The habitat, according to Linnæus, is now *India orientali.*

As *M. jubata* is generically distinct from *M. tetradactyla*, and no old name being available, I propose the name "Falcifer."[2]

The species of Myrmecophagidæ, therefore, would stand as follows:

Cyclopes Gray, 1821.

C. didactylus (Linnæus).

Myrmecophaga Linnæus, 1758.

M. tetradactyla Linnæus.
M. tetradactyla straminea (Cope).
M. longicaudata Wagner.
M. sellata Cope.

Falcifer, Rehn, 1900.

F. jubata (Linnæus).

II. DIDELPHIS.

Under this generic name in the tenth edition are described five species, *i.e.*, Marsupialis, Philander, Opossum, Murina, and Dorsigera. Of these, three have been since separated generically; Philander becoming *Philander philander* (1808), Opossum becoming *Metachirus opossum* (1854), and Murina becoming *Marmosa murina* (1821). The species Dorsigera is a synonym of Murina, and Marsupialis is unrecognizable (see Alston, *Biol. Centr. Amer.*, p. 196, footnote, and Allen, *Bull. Amer. Mus. Nat. Hist.*, Vol. IX, p. 43).

[1] Two of these references are inaccessible to the writer.

[2] From *falx* + *fero*, 'sickle-bearing,' referring to the sickle-shaped claws of the fore feet.

The type of the genus Didelphis is, therefore, the last one removed — *D. opossum.*[1]

The large opossums formerly called Didelphis require a name, and the oldest one available is Sarigua Muirhead, with *S. virginiana* as the type. The complete reference is *Sarigua* Muirhead, *Brewster's Amer. Edition Edinburgh Encyclopædia*, Vol. XII, Part II, p. 505, 1819. The writer wishes to thank Dr. T. S. Palmer, of Washington, for calling his attention to this name.

The nomenclature of the opossums is in a very unsatisfactory condition, and the group is much in need of a revision, with a large amount of material for examination.

The recognized Linnæan species stand at present as :

Philander philander (Linnæus).
Didelphis opossum Linnæus.
Marmosa murina (Linnæus).

The large opossums should stand as :

Sarigua karkinophaga (Zimmermann).
Sarigua virginiana (Kerr).
Sarigua virginiana pigra (Bangs).
Sarigua virginiana californica (Bennett).
Sarigua aurita (Wied).
Sarigua azaræ (Temminck).

The species of *Didelphis* (= *Metachirus* Burmeister) stand as follows :

Didelphis opossum Linnæus.
Didelphis nudicaudata E. Geoffroy.
Didelphis crassicaudata Desmarest.

Acad. Nat. Sciences, Philadelphia,
March 24, 1900.

[1] Some hold that the *opossum* is not determinable, but the plates in Seba's work, referred to by Linnæus, though poor, are recognizable.

KARPINSKY'S GENUS HELICOPRION.

A REVIEW.

C. R. EASTMAN.

It is a significant and decidedly unwelcome truth that not one in one hundred essays on paleontological subjects receives anything like the elaborate care and finish which Dr. Karpinsky,[1] the Director of the Imperial Russian Geological Survey, has bestowed upon the remarkable ichthyodorulites which he describes under the name of "Helicoprion." Within the compass of 110 pages, enriched by seventy-two text-figures and four quarto plates, the subject is treated from all possible standpoints — historical, geological, chemical, histological, and biological. The result is a very gratifying addition to the knowledge of Palæozoic fishes.

Helicoprion is a fitting title for the peculiar "spiral saws," coiled in three and a half whorls and armed with upwards of 150 sharp teeth, which have recently been discovered in the Permo-Carboniferous (Artinsk Series) of the government of Perm. Although ammonitic in outward appearance, inspection shows these bodies to be of elasmobranch nature, the nearest allied structures being found amongst the Edestidæ. A complete summary of the literature of Edestidæ is given in the first twenty pages, with text-figures of all the more important species that have been described. Next follows a discussion of the stratigraphic position of the Russian specimens, and finally a minute account of their form, structure, and general nature. At the end the results of the investigation are tabulated under sixteen different headings, and a restoration is attempted showing the imaginary position occupied by the spiral during life of the creature. Few will be prepared to admit, however, that

[1] Karpinsky, A. Ueber die Reste von Edestiden und die neue Gattung Helicoprion, *Verh. k. russ. min. Ges. St. Petersburg*, Ser. 2, Bd. xxvi, No. 2, 1899.

this highly fanciful sketch can be taken seriously, and, therefore, the least said about it the better.

Of the two leading theories as to the position in the body of Edestus "spines," the first ascribes them to the jaws of a shark or skate, and the other to the median line of the back, some distance in advance of the dorsal fin or in a cephalic position. Dr. Bashford Dean[1] confidently asserts that the evidence of *Edestus lecontei* leaves no room to doubt that "the spine had its origin as a metameral structure whose basal portion lay within the integument, and traversed longitudinally a number (seven at least) of body segments." This supposed metameral origin of Edestus is still more strongly insisted on by the same author in his *Fishes, Living and Fossil* (pp. 28–30). On the other hand, those who deny that these structures are dermal defenses and regard them as part of the dentition are impressed by the close similarity in form and structure of the enameled denticles as compared with ordinary sharks' teeth, especially those of Carcharodon and certain Palæozoic genera. As it is difficult to conceive of such unwieldy, bilaterally symmetrical bodies being located within the mouth cavity, they have been compared by the elder Agassiz with the rostrum of swordfishes, and by Miss Hitchcock with the symphysial dentition of Onychodus. Dr. Karpinsky's conclusion that the spiral was external and attached to the upper jaw in the manner shown is based on the following considerations: (1) Helicoprion belongs undoubtedly to an elasmobranch; (2) the bases of all the segments ("teeth") of the spiral were imbedded in the soft parts of the fish; (3) the spiral must have been situated in the median vertical plane of the fish; (4) the whole of the spiral, except the large end, must have been exposed; and (5) the large size of the spiral (26 cm. in diameter) renders it highly improbable that it could have been contained within the mouth cavity.

Dr. A. S. Woodward,[2] in a review of Karpinsky's memoir, likewise admits that "the conception of a gigantic shark armed in both jaws with several series (whorls) of teeth, like those

[1] *Trans. New York Acad. Sci.*, vol. xv (1897), p. 68.

[2] *Geol. Mag.*, vol. vii (1900), p. 36.

now described under the name of Helicoprion, is, indeed, sufficiently startling." Nevertheless this distinguished expert brings forward considerable evidence in favor of the view that Edestus and Helicoprion should be looked upon as Palæozoic sharks "with sharp, piercing teeth, which were never shed, but became fused into whorls as the animal grew." The question, then, as to whether these objects are segmented spines or teeth would seem to remain as puzzling as ever, in spite of the abundance of new light thrown on their structure by Karpinsky's studies. Analogy alone is insufficient to settle the problem; we must have the positive evidence that only fresh material can supply. Should several whorls, or "spines," be discovered in natural association, that is, belonging to one individual, it would be a fatal argument against their being dermal defenses, and we should have to look upon them as actual, veritable teeth, as suspected by Woodward.

FIG. 1.—*Sandalodus larvissimus.* N and W. Keokuk limestone, Keokuk, Iowa. Posterior dental plate of left mandibular ramus. × ⅔.

As far as analogy goes, however, no one can deny that there are a number of points in common between the segments of Helicoprion and various forms of cochliodont and petalodont dentition, where the earlier formed teeth are permanently retained, and there are all degrees of fusion and coiling. Karpinsky himself calls attention to certain points of similarity in the structure of Janassa, Glossodus, and Helodus, and since his memoir appeared an important paper on the dentition of the first-named genus has been published by Jaekel,[1] which calls to mind more forcibly than ever the resemblance to a por-

[1] Jaekel, O. Ueber die Organisation der Petalodonten, *Zeitschr. d. d. geol. Ges.*, Bd. li (1899), pp. 258–298. *Cf.* Text-fig. 1, p. 265.

tion of the whorls of Helicoprion. As for *Helodus coxanus*, cited by the Russian director, it may be remarked that, after a study of the type specimen (now in the keeping of the U. S. National Museum) in connection with a large series of dental plates of *Cochliodus latus* from the same horizon, the reviewer is satisfied that they were associated in one and the same mouth. *H. coxanus* is, accordingly, but another name for one of the several arched series of knob-like teeth situated in advance of the large pair of dental plates in the upper and lower jaws of *Cochliodus latus*.

A very curious case of coiling among cochliodonts which has not been previously reported occurs in *Sandalodus lævissimus*, which accompanies *Cochliodus latus* in the Keokuk limestone of Iowa and Illinois. The initial portion of the large posterior dental plate is wound upon itself one and a half times before expanding into the functional grinding surface characterizing the adult, and in *Deltodus undulatus* from the Burlington limestone a like condition obtains on a somewhat smaller scale. These instances deserve notice, when we consider the variety of evidence it is necessary to take into account before passing judgment on the extremely problematical nature of the Edestidæ. In Fig. 1 is shown one of the most perfect examples of Sandalodus ever discovered, and its bearing on the present subject will be evident from inspection.

SYNOPSES OF NORTH-AMERICAN INVERTEBRATES.

XI. The Catometopous or Grapsoid Crabs of North America.

MARY J. RATHBUN.

One of the most familiar forms of the Catometopa is the common ocypode, or sand crab, which lives on the beaches in abundance south of New England. It digs holes in the sand, occasionally retreating to the water when frightened. It is protected by its color, resembling that of the sand, and by the swiftness of its movements.

The fiddlers, which may be recognized by the extraordinary development of one of the claws of the male, are represented by many species which burrow in sand beaches or in muddy banks of streams and ditches in the salt marshes, while at least one species, *Uca minax*, extends up rivers quite to fresh water.

Of the Grapsidæ, the *Sesarma reticulatum* also burrows in muddy banks. Its congener, *S. cinereum*, is sometimes known as the "wood crab," from its occurrence under logs and drift and about wharves, wood piles, etc. On the Pacific coast, the species of Hemigrapsus are abundant under stones and on mud flats in salt or brackish water.

The common land crab of tropical America and the West Indies, *Cardisoma guanhumi*, occasionally makes its appearance in Texas. It is the only member of the Gecarcinidæ which comes within the limit of this paper.

The Pinnotheridæ are readily known by their small size, small eyes, often soft or membranaceous integument, and commensal habit, dwelling often in the shells of bivalve mollusks, in the tubes of annelids, or on sea-urchins. The best known species is the common oyster crab, *Pinnotheres ostreum*, which is often cooked and eaten with oysters.

The Palicidæ, some of which appear in our list, are small anomalous forms, inhabitants, chiefly, of warm waters or of considerable depths. Four species are known to occur either in the Gulf or in the Cape Hatteras region in less than one hundred fathoms.

TRIBE CATOMETOPA OR GRAPSOIDEA.

Carapace broad anteriorly, often subquadrate, sometimes subglobose, truncate or arcuate anteriorly, but not rostrate. Front bent downward. Epistome short, often almost linear. The pairs of branchiæ are usually fewer than nine in number; the efferent channels open at the sides of the endostome. The male verges are inserted either in the sternal plastron, or in the basal joints of the last pair of legs, thence passing through channels in the sternum beneath the pleon.

KEY TO THE FAMILIES OF THE TRIBE CATOMETOPA.

A. Carapace hard and firm. Front, orbits and eyestalks not very small. Buccal frame quadrate anteriorly.
  B. Last pair of feet not remarkably reduced.
    C. Carapace moderately convex or depressed; branchial regions not greatly dilated.
      D. Third maxillipeds with the fifth joint articulated at the front inner angle usually. Front of moderate width or very narrow. Eyestalks often greatly elongate
        OCYPODIDÆ Leach
      D'. Third maxillipeds with fifth joint articulated at apex or front outer angle of fourth. Front usually broad. Eyestalks of moderate size
        GRAPSIDÆ Milne Edwards
    C'. Carapace very convex, especially dilated over and in front of the branchial regions; antero-lateral margins entire or subentire, and strongly arcuate. Terminal joint of walking legs often armed with longitudinal rows of spines
      GECARCINIDÆ Milne Edwards
  B'. Last pair of feet remarkably reduced . . . PALICIDÆ Rathbun
A'. Carapace often more or less membranaceous. Front, orbits and eyestalks usually very small. Buccal frame arcuate anteriorly. Of small size . . . . . PINNOTHERIDÆ Milne Edwards

KEY TO THE GENERA OF THE FAMILY OCYPODIDÆ.

A. Carapace trapezoidal or quadrate. Eyestalks often elongate.
  B. Lateral margins entire.

C. Eyestalks stout. Chelæ in male somewhat unequal Ocypode
C'. Eyestalks slender. Chelæ in male extremely unequal . Uca
B'. Lateral margins toothed.
C. Lateral margins parallel or nearly so . . . Euchirograpsus
C'. Postero-lateral margins posteriorly converging . Euryplax
A'. Carapace with antero-lateral margins arcuate. Eyestalks of moderate length.
B. Carapace with margins spinous . . . . . Geryon
B'. Carapace with margins feebly dentate . . . . Speocarcinus

FIG. 1. — Ocypode albicans, carapace.

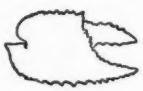

FIG. 2. — Ocypode albicans, chela.

THE SPECIES OF OCYPODIDÆ.

Genus Ocypode Fabricius . . . . . *O. albicans* Bosc, *MSG*
= *O. arenaria* Say

Genus Uca Leach.

Key to Species.

A. Inner surface of palm of large cheliped without an oblique ridge.
B. Carapace very short, broad, and convex. Abdomen of male wide, increasing noticeably in width towards proximal end
U. subcylindrica (Stimpson), *G*[1]
B'. Carapace of moderate width and convexity. Abdomen of male of moderate width, its sides subparallel
U. pugilator (Bosc), *MSG*
A'. Inner surface of palm with an oblique ridge.
B. Oblique ridge terminating at carpal cavity.
C. Front (between the eyes), very shallow and broad. Claws with red spots at the articulations
U. minax (Le Conte), *MSG*
C'. Front narrow, its sides oblique.
D. Eyebrow (or surface between the orbit and the dorsum) nearly vertical, scarcely visible in a dorsal view. Space on inner surface of palm, between carpal cavity and dactylus, coarsely granulate
U. pugnax (Smith), *MSG*
D'. Eyebrow inclined, visible in a dorsal view. Space between carpal cavity and dactylus finely granulate
U. pugnax rapax (Smith), *G*

[1] Texas.

B'. Oblique ridge not terminating at carpal cavity, but continued by an angular turn to near the superior margin.

C. A tooth or spine on the inner surface of the carpus of the large cheliped. Ridge on inner surface of palm strongly produced . . . . *U. spinicarpa* Rathbun, sp. nov.,[1] *G*

C'. No tooth nor spine on inner surface of carpus.

D. Superior surface of palm turned abruptly at right angles with outer surface, and forming a flat or concave surface *U. coloradensis* Rathbun, mouth of Colorado River

D'. Superior surface of palm rounding gradually into outer surface . . . . . *U. gracilis* Rathbun, *D*

Genus Euchirograpsus Milne Edwards *E. americanus* A. Milne Edwards, *S*

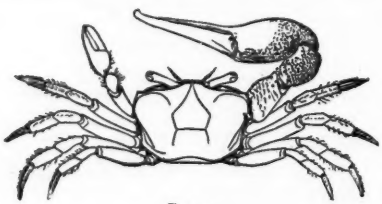

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 3. — Uca pugilator. FIG. 4. — Uca pugilator, inner side of large chela.
FIG. 5. — Geryon quinquedens, carapace.

Genus Euryplax Stimpson . . . . . *E. nitida* Stimpson, *G*
Genus Geryon Krøyer . . . . . *G. quinquedens* Smith, *NM*

Genus Speocarcinus Stimpson.

Key to Species.

A. Lateral margin of carapace with three notches *S. carolinensis* Stimpson, *S*

A'. Lateral margin of carapace with two notches *S. californiensis* (Lockington), *D*

THE SPECIES OF GECARCINIDÆ.

Genus Cardisoma Latreille . . . . . *C. guanhumi* Latreille, *G*

KEY TO THE GENERA OF THE FAMILY GRAPSIDÆ.

A. Antennæ covered by the front.

B. External maxillipeds without a piliferous ridge.

C. Carapace as long as or longer than broad . . . . Planes

C'. Carapace considerably broader than long.

[1] Type, U. S. Nat. Mus., No. 22,183, Galveston, Texas; Boll, collector.

D. External maxillipeds with a wide rhomboidal gape Pachygrapsus
D'. External maxillipeds with a narrow gape Hemigrapsus
B'. External maxillipeds with a piliferous ridge . . . . Sesarma
A'. Antennæ visible from above . . . . . Plagusia

THE SPECIES OF GRAPSIDÆ.[1]

Genus Planes Leach

P. minutus (Linnæus), *MSAPD*, at surface, on floating weed

Genus Pachygrapsus Randall.

Key to Species.

A. Lateral margins strongly arcuate . . . *P. crassipes* Randall, *PD*
A'. Lateral margins converging posteriorly from the lateral tooth *P. transversus* Gibbes, *M*[2]*GD*[3]

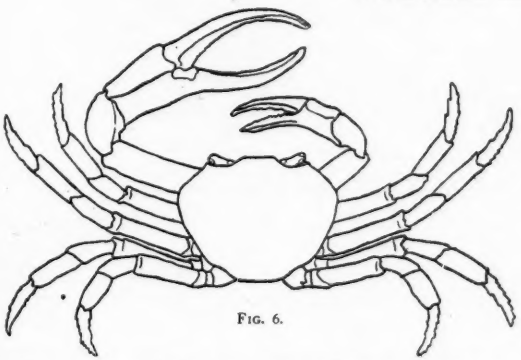

FIG. 6.

FIG. 7.

FIG. 6. — Cardisoma guanhumi. FIG. 7. — Cardisoma guanhumi, outer maxilliped.

Genus Hemigrapsus Dana.

Key to Species.

A. Front with a deep sinus at the middle *H. oregonensis* (Dana), *APD*
A'. Front arcuate, very slightly sinuous . . . *H. nudus* (Dana), *APD*

Genus Sesarma Say.

Key to Species.

A. Lateral margin toothed behind the orbital angle *S.* (*Sesarma*) *reticulatum* Say, *MSG*
A'. Lateral margin entire . . *S.* (*Holometopus*) *cinereum* (Bosc), *MSG*
Genus Plagusia Latreille . . . . . *P. depressa* (Fabricius), *S*

[1] *Grapsus grapsus* (Linnæus), a tropical species, has been taken at Cape Cod from the bottom of a whaler just returned from a voyage.

[2] Occasional. [3] California (Kingsley).

KEY TO THE GENERA OF THE FAMILY PINNOTHERIDÆ.

A. Carapace convex. Eyes small.
B. Ischium of outer maxillipeds rudimentary.
C. Palpus of outer maxillipeds with three joints.
D. Last joint of palpus articulated on inner margin of preceding joint.
E. Third ambulatory leg longer and stronger than the others, usually considerably so . . . Pinnixa
E'. Third ambulatory leg very little, if any, longer than the others.
F. Carapace without a longitudinal suture behind the orbits . . . . . Pinnotheres

FIG. 8.

FIG. 9.

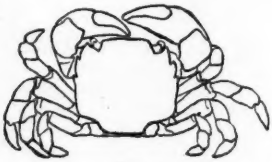

FIG. 10.

FIG. 8. — Pachygrapsus transversus, carapace.
FIG. 9. — Pachygrapsus transversus, chela.
FIG. 10. — Hemigrapsus nudus.

F'. Carapace with a longitudinal suture behind the orbits enclosing between them the median area . . . . . Raphonotus
D'. Last joint of palpus articulated at end of preceding joint Echinophilus
C'. Palpus of outer maxillipeds with two joints . Cryptophrys
B'. Ischium of outer maxillipeds distinctly developed . Opisthopus
A'. Carapace flat, suborbicular, truncate behind. Eyes large (for the family), each eyestalk as long as half the width of the front Zaops

THE SPECIES OF PINNOTHERIDÆ.

Genus Pinnixa White.

Key to Species.

A. Carapace firm.
B. Pollex of cheliped distinctly developed.
C. Pollex much shorter than the dactylus, and usually bent downwards toward the extremity.
D. Transverse crest on the cardiac region short, not extending across the entire carapace.

E. Propodus of third ambulatory leg as broad as long, or nearly so . . *P. chætopterana* Stimpson, *M*

E'. Propodus of third ambulatory leg distinctly longer than broad.

F. Dactylus of third ambulatory leg more than half the length of the propodus, measured on the posterior margin.

G. Second pair of ambulatory legs slender, filiform, subcylindrical *P. sayana* Stimpson, *M*

G'. Second pair of ambulatory legs compressed, not extremely slender nor filiform.

H. Cardiac ridge sinuous, in dorsal view *P. occidentalis* Rathbun, *AP*

H'. Cardiac ridge straight, or nearly so, in dorsal view *P. californiensis* Rathbun, *D*

F'. Dactylus of third ambulatory leg less than half the length of the propodus, measured on the posterior margin . *P. littoralis* Holmes, *P*

D'. Transverse crest on the cardiac region extending across the entire carapace *P. cristata* Rathbun, sp. nov.,[1] *M*

FIG. 11.

FIG. 12.

FIG. 13.

FIG. 11. — Pinnixa longipes.
FIG. 12. — Pinnixa longipes, outer maxilliped.
FIG. 13. — Pinnotheres ostreum, ♀.

C'. Pollex as long, or nearly as long, as the dactylus, and not bent downward.

D. Merus of third ambulatory leg longer than half the width of the carapace . . . *P. longipes* (Lockington), *P*

D'. Merus of third ambulatory leg shorter than half the width of the carapace.

E. Length of carapace half its width *P. cylindrica* (Say), *SG*

E'. Length of carapace much less than half its width *P. tubicola* Holmes, *D*

B'. Pollex wanting, represented only by the spiniform angle of the palm . . . . . *P. monodactyla* (Say), American?

[1] Type, one female, Beaufort, N. C. (Union College collection).

A'. Carapace thin, membranaceous, yielding to slight pressure
P. faba (Dana), *AP*

Genus Pinnotheres Latreille.

Key to Species.

A. Palm widening towards the distal end.
B. Last joint of palpus of outer maxilliped very slender and much smaller than the preceding joint.
C. Carapace of female very thin and membranaceous. Surface smooth and shining . . . . . *P. ostreum* Say, *MS*
C'. Carapace thicker and firmer. Surface covered with a dense pubescence . . . . . *P. maculatus* Say, *MSG*

FIG. 14. — Pinnotheres maculatus, ♂.

FIG. 15. — Palicus bahamensis.

B'. Last joint of palpus of outer maxilliped large, more than half the width of the preceding joint . . . . *P. nudus* Holmes, *D*
A'. Palm linear . . . . . *P. byssomiæ* Say, "Our southern coast."

Genus Raphonotus Rathbun.

Key to Species.

A. Palm of cheliped widening from the proximal to the distal end
R. subquadratus (Dana), *AP*
A'. Palm of cheliped not widening from the proximal to the distal end; slightly swollen at the middle . . *R. lowei* Rathbun, sp. nov.,[1] *D*

Genus Echinophilus Rathbun, nov. *E. mellitæ* Rathbun, sp. nov.,[2] *MSG*
Genus Cryptophrys Rathbun . . . . . *C. concharum* Rathbun, *PD*
Genus Opisthopus Rathbun . . . . . *O. transversus* Rathbun, *D*
Genus Zaops Rathbun, nov. . . . . Type, *Z. depressa* (Say), *M*

[1] Types, U. S. Nat. Mus., No. 23,437, San Pedro Bay, Cal., in siphon of *Pholas pacifica*; H. N. Lowe, collector; 2 ♀.

[2] Types, U. S. Nat. Mus., No. 23,434, Pensacola, Florida, on *Mellita testudinata*; J. E. Benedict, collector.

The Species of Palicidæ.

Genus Palicus Philippi.[1]

Key to Species.

A. Crests on the second and third abdominal segments, and on the fifth sternal segment, not forming conspicuous laminiform expansions visible in a dorsal view.

B. Anterior margin of meri of second and third ambulatory legs terminating in a nearly rectangular non-projecting tooth
P. alternatus Rathbun, *M(CH)G*

B'. Anterior margin of meri of second and third ambulatory legs terminating in a spiniform, projecting tooth.

C. Branchial regions much swollen
P. obesus (A. Milne Edwards), *G*

C'. Branchial regions not swollen *P. faxoni* Rathbun, *M(CH)*

A'. Crests on the second and third abdominal segments, and on the fifth sternal segment forming conspicuous laminiform expansions visible in a dorsal view . . . . . *P. sica* (A. Milne Edwards), *G*

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[1] The species figured, though not entered in the list, is inserted to illustrate the genus.

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REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

Man and his Ancestor. — In an admirable little volume of 238 pages Mr. Charles Morris has presented the leading facts that go to show that man has been the outcome of a development from the lower animals. This study in evolution is written in terse and untechnical language. It is addressed to "those who are evolutionists in principle to learn on what grounds their acceptance of this phase of evolution stands, and to aid those who are at sea on the whole subject of man's origin to reach some fixed conclusion." The clear and logical interpretation of the facts — themselves established for the most part beyond controversy — certainly justifies the author's hope "that it may carry some doubters to solid land and teach some believers the fundamental elements of their faith." In a word, it is a well-written "popular treatise" that deserves to be widely read.

Two views of the origin of man exist: either he came into existence through direct creation, or by development from the lower animals. The former mode is not susceptible of proof, the latter is supported by our author with facts drawn from both biology and anthropology. Some of the principal vestiges of the ancestry of man which he carries in his own body are described. Brief mention is made of the principal discoveries of human remains and articles manufactured by man that have come down to us from prehistoric times. It is to be especially observed that all archæological evidence is cumulative, indicative of constant improvement. The four most marked distinctions between man and the lower animals are considered at some length. In the chapter upon "the conflict with nature" are set forth the prevailing beliefs regarding the time and place of man's origin, the influence environment has had upon the race, and the traces of ascent discernible in racial differences.

Notes. — In Vol. X, Nos. 4 and 5, of *L'Anthropologie* appears a valuable article upon polymasty and polythely in man. Dr. P. J. Stoyanov presents a number of new cases and reviews the results obtained by other investigators.

Mr. W. C. Mills, curator of the museum of the Ohio State Archæological and Historical Society, has prepared a report of the field work of the society for the year ending May 31, 1898, that has been published in Vol. VIII of the *Annual Publications of the Society.* The work consisted in the exploration of mounds and the addition of new data to the state archæological map. The explorations seem to have revealed little that is new, though the discovery of post molds in a mound in Knox County is worthy of note. These molds were in the form of a square twenty-seven feet on each side. In the center of the enclosure was a fire pit of yellow clay six feet in diameter. In another mound five headless skeletons were found promiscuously heaped together. This recalls the discovery made at the Turner Mounds, a number of years ago, of sixteen skulls that had been buried together.

In the *Bulletin of the American Museum of Natural History*, Vol. XIII, pp. 69–86, appears an article by Mr. A. L. Krœber upon the "Symbolism of the Arapaho Indians." It is very concisely written, and illustrated with 138 figures representing the symbols most commonly employed. These range from a straight line (Fig. 24) to a silhouette of the human figure (Fig. 124). Mr. Krœber concludes that the symbolic tendency prevails over the decorative in Arapaho art.

In the *American Anthropologist* (N. S.), Vol. II, No. 2, is published a paper by Dr. J. R. Swanton upon the "Morphology of the Chinook Verb" that should be of interest and value to students of the science of linguistics. It is an exhaustive study of the verb, prefaced by a general account of the other parts of speech in the Chinook language. This thesis was accepted at Harvard University as fulfilling the requirements for the degree of Doctor of Philosophy. F. R.

ZOÖLOGY.

A Zoögeographic Scheme for the Mid-Pacific.[1] — Some time ago (*American Naturalist*, No. 396, p. 975, December, 1899) we called attention to C. Hedley's views on the former existence of an antarctic continent; now, a recent paper has come into our hands on a subject that is intimately connected with the question of the origin of the faunas of the Central Pacific Islands, Australia, and New Zealand.

[1] Hedley, Chas. *Proc. Linn. Soc. N. S. Wales* (1899), Pt. iii, July 26.

Hedley maintains that the faunas of Australia and the Pacific Islands — generally united into the Australian region — have developed under two completely different conditions. On the one side, the western, continental conditions prevailed, Australia proper being connected with New Guinea, and New Guinea, in turn, through the Solomon Islands, New Hebrides, and New Caledonia, with New Zealand, while the Fiji Islands formed another branch of this old continental mass, being connected with the New Hebrides and Solomon Islands.

On the other side, the eastern, we have the rest of the Pacific Islands, where oceanic conditions have always prevailed, the different islands of the Gilbert, Ellice, Samoan, Tonga groups, etc., never forming a continuous continent.

This fundamental difference finds its expression in the faunas of these two parts, in so far as in the western part a "harmonic" fauna (G. Baur) exists, that is to say, a fauna that is composed of the chief groups of animal life, without considerable gaps. In the eastern part, however, such gaps are very frequent and mark the fauna at once as a "disharmonic," many important groups of animals being completely missing. In the western part a continuous migration over the whole extent of this continental mass was possible, thus favoring more even distribution of the land animals over the whole area, while in the eastern part the land fauna could only migrate by drift over the intervening parts of the ocean. which excludes at once a large number of animals.

In the *fauna of the western, or continental, part* we can distinguish three chief constituents: (1) an Australian-Autochthonian (Tate), or Eyrean (Spencer), which is restricted to Australia proper, and hardly passes beyond Queensland to the north; (2) the so-called Euronotian (Tate), or Bassian (Spencer), which is the most characteristic Australian element, and of antarctic origin; it entered Australia by the south, over Tasmania, and crossed Torres Strait into New Guinea, reaching its limit in the Solomon Islands; (3) the Torresian (Spencer) element. Its center lies in New Guinea, from whence it was connected with the Indo-Malaysian fauna. It sends off from New Guinea two branches, the one crossing Torres Strait southward and entering Queensland, the other one traversing New Britain, New Ireland, the Solomons, sending an offshoot to Fiji and another along the chain of the New Hebrides and New Caledonia, ultimately arriving at New Zealand.

In New Zealand the southern advance of the Torresian element

was met by a strong antarctic element, coming from the supposed antarctic continent. The latter may be traced up to New Guinea and is probably older than the other antarctic element that enters Australia from the south.

The *Polynesian fauna*, that of the *eastern, oceanic part*, has derived its population from two sources. The first way was from the Moluccas or the Philippine Islands through the Pelews and Carolines to the Marshalls, and thence down along the chain of archipelagoes to the Paumotu Islands; this is called the Micronesian route. The other way, the Melanesian route, started from the Fiji Islands, belonging to the Australian continental fauna, whence the respective animals crossed over by drift to the Tonga and Samoan groups. By this way Torresian, as well as antarctic elements, both being represented in the Fijis, have contributed to the Polynesian fauna, while by the first way only Indo-Malaysian (closely connected with the Torresian) elements could immigrate.

We cannot deny that this theory of the origin of the Pacific faunas has many points in favor of it; especially the explanation of the connection of the continental faunas of Australia, New Guinea, etc., to New Zealand seems very acceptable. On the other hand, Hedley's opinion of the oceanic nature of the Polynesian fauna cannot be accepted without comment. Indeed, there seems to be a sharp line, just where Hedley draws it, between Fiji on one side and the Tonga and Samoan groups on the other; but whether the "disharmonic" fauna of Polynesia is to be explained by, and is synonymous with, "oceanic origin" remains to be demonstrated. The terms "harmonic" and "disharmonic" — although they may be useful sometimes — are only of relative value; New Zealand, for instance, has decidedly a "disharmonic" fauna, but Hedley himself believes it to be of continental origin.

And, further, the theory of the oceanic origin of the Polynesian fauna is opposed to the views of some of the most prominent recent writers in *Zoögeography*. Hedley refers only to the opinion of G. Baur (as expressed in No. 31, 1897, of this journal), and, indeed, in one of the instances which he quotes (p. 412) Baur's argument derived from the distribution of Pocillopora and Trapezia is not very convincing. But there is another vigorous champion of the continental origin of the Polynesian fauna, namely, H. von Ihering, and his arguments are certainly worth discussing. Von Ihering traces the continental origin of the Polynesian fauna far back into the Mesozoic time and thus explains the "disharmonic" character of it;

the lack of certain groups of animals is apparently due to the fact that they did not exist at all at the time when there was a connection of these parts with others.

But we need further investigations on this subject, and it is not advisable to express at present a definite opinion on this topic. Hedley's paper gives one solution of the problem, and, indeed, his arguments are very important, and his theory may finally prove to be correct, at least to be the most probable.

A. E. O.

The Distribution of the Opilionidæ. — Dr. J. C. C. Loman[1] has published a synopsis of the facts known about the distribution of the Opilionidæ, illustrated by four maps. It is hardly necessary to discuss the paper in detail, as the author intended simply to give the facts, without giving an explanation of them. We should like, however, to call attention to certain features of the distribution of these animals which seem to furnish additional evidence in favor of von Ihering's theories.

It will be remembered that, according to von Ihering, South America is no zoögeographical unit, but consists of two separate centers of origin; the one is situated in its southern part and was connected at a certain time with the antarctic continent; this is called "Archiplata"; the other one comprises the northern parts of the present South America, and was connected, in Mesozoic times, with West Africa. This Mesozoic continental mass has been called by von Ihering by the name of "Archhelenis."

Now, according to Loman's map (Pl. XI, Fig. 2), the distribution of the Opilionid family, Gonyleptoidæ (expressed in green dots), is in South America and the West Indies on the one side, and in West Africa on the other, and it would seem impossible to explain it in any other way than by accepting von Ihering's Archhelenis theory.

The relations of the southern parts of the present continents to the antarctic continent supposed to have existed formerly are expressed in the distribution of another family of Opilionids, the Triænonychoidæ. As Loman's map (Pl. XI, Fig. 4) indicates (by red dots), this family has been found in South Africa, Madagascar, South Australia, the Fijis, and in Chili. This distribution corresponds closely to that of other antarctic animals.

A. E. O.

[1] Ueber die geographische Verbreitung der Opilioniden, *Zool. Jahrb.*, Abt. f. Syst., Bd. xiii (1900).

"The Management and Diseases of the Dog,"[1] by John Woodroffe Hill, is a most valuable addition to canine literature, containing the results of the author's many years of exceptional experience with canine diseases. We are glad to notice that in the preface Mr. Hill most emphatically expresses his views on the absurd law for muzzling dogs during a rabies panic as follows: "utterly ineffectual in stamping out rabies; partial and aggravating in its administration; injurious and cruel to the subject." His views with relation to the cure of this disease are interesting and somewhat at variance with those generally entertained at the present time, in so far as the human subject is concerned. After stating that "it was recognized centuries ago, and the alarm engendered appears to have been as great then as in the present day," he goes on to say that "rewards have been offered for the discovery of a cure, but the probability of their ever being claimed is extremely dubious, — especially so long as spurious hydrophobia and various phases of hysteria are indiscriminately mixed up and mistaken for the real malady." The measures to be taken when human beings have been bitten by a suspected dog are described, and as these are of such vital interest, it seems best to quote his directions.

"With regard to ourselves, all dog bites, as a precautionary measure, should be treated as if they were inflicted by a rabid animal, *i.e.*, by immediate suction, followed by the application of the actual cautery, nitric acid, or pure carbolic acid. When rabies is suspected the suction should be directly followed by complete excision of the wound, performed as quickly as possible; after which, without loss of time, the cautery or acid should be freely used. Compression above the wound, especially in the first instance, is also valuable. Failing the adoption of these measures, or even accompanying them, the Russian or Turkish bath should, if possible, be immediately had recourse to, and, in the absence of such measures, free and intense perspiration should be promoted by other means, such being the most efficacious treatment at present known. . . . I also advise a powerful stimulant before taking the bath, and subsequently full doses of chlorate of potash and iron."

The opening chapter is on general management, food, exercise, washing, grooming, clothing, kennel arrangement, disinfection, administration of medicine, and nursing. This last is a subject little studied in connection with animals, but it is far more difficult to nurse

[1] Fifth edition. London, Swan, Sonnenschein & Co.; New York, The Macmillan Company, 1900. 531 pp., 8vo.

a dumb creature, that cannot express clearly its needs, than a human being, and taxes one's intuition far more than can be realized by the inexperienced, who have never studied and contrasted the normal with the abnormal expressions and habits of animals. He discusses the above subjects very briefly, too briefly, in fact, as he advises some things which are opposed to the methods of many dog breeders, without sufficiently stating his reasons. For instance, on the subject of time of meals, he says: "Where only one meal is allowed [it should be given], at midday"; where only one meal is allowed it is necessarily a heavy one, and midday is, in winter, a time when a dog has generally just finished, or about to begin, his exercise, and in summer is the hottest part of the twenty-four hours. A heavy meal, while acceptable to the dog at any time, is generally given at the end of the day, when all exercise is over.

He also states: "Animal food (except an occasional bone) is not advisable in any breed of young dog,[1] until four or five months old, and it should then be *gradually, not suddenly*, introduced into the diet." He gives no reasons for the above, which is a much discussed question, and about which every breeder varies in some degree from his neighbor; but the best authorities advise the use of meat in some form or other and in variable quantities.

Mr. Hill endeavors to correct the absurd ways in which the average feminine dog owner cares for her pets, and in reading his book it becomes obvious that, if it were not for her mistaken kindness and overfeeding, the veterinary would have much fewer rare diseases and abnormal growths to study.

The diseases are classified in groups, according to the various parts of the system which they attack, and are described in a general way; then causes, symptoms, and treatment are given, and this method greatly simplifies the diagnoses, and the author's explicit and brief style throughout cannot be too highly praised.

The book is as interesting to members of the profession as to the amateur, on account of Mr. Hill's large experience with rare diseases, which he fully describes. One of the rarest which he gives is "verminous bronchitis," generally confined to animals under eight months old. An autopsy showed, in addition to pneumonia, "numerous small parasitic worms in the trachea and bronchial tubes."

Throughout the book there are liberal quotations from other authorities: from Ainslie, a case of inversion of the stomach; Hutch-

[1] Obviously meant to be "young dog of any breed."

inson, a case of intussusception of the ileum and cæcum; Weber, Leblanc, Trasbot, Youatt, Gowing and son, etc.

The chapter on Accidents and Operations covers the ground very thoroughly for the first heading, and includes, under the second, some of the more difficult operations as well as the lesser ones, such as removing of dewclaws, cropping, tailing, etc.

Mr. Hill strongly advocates the use of chloroform, saying: "On the score of humanity, however, chloroform chiefly demands our attention, and with the knowledge that we are not inflicting pain is gained strength of nerve, confidence in ourselves, and, probably, a more successful issue to our patient."

To members of his profession he writes: "We must remember that the most sacred duty of the veterinary surgeon is to prevent or alleviate pain and distress in animals."

An appendix gives a table of Medicines and their Doses, Poisons and their Antidotes, and also a Standard of Points for Judging. The standards are nearly all taken from those recommended by the various dog clubs, and consequently there are a few breeds which are not included, owing to inability to obtain a recognized standard of points in connection with them.

The photographic reproductions of famous dogs, the work of Thomas Fall, F.R.P.S., the well-known and artistic English photographer, are very handsome.

The index is full and accurate, the type clear and on good paper, and the book is of a convenient size. There are, besides those noticed in some of the quotations, many instances of defective style that might be quoted, but these are not of a kind that detract from the usefulness of the book.

There is no list of illustrations, and, considering the excellence of these, and that there are no less than eleven plates, most of them giving two figures of celebrated dogs, this is a serious omission, one that ought not to have occurred, especially in a fifth edition.

A. V. H.

Studies on Hirudinea.—A posthumous paper by the late Arnold Graf[1] discusses exhaustively the structure and activities of the excretory organs of the leech. Though not concerned primarily with classification, it contains figures of several North-American species of Glossiphonia ("Clepsine") new to science. Graf's studies of

[1] Hirudineenstudien, *Abh. der Kaiserl. Leop.-Carol. Deutschen Akademie der Naturforscher* (Halle), Bd. lxxii (1899), Nr. 2, pp. 217–404, Taf. I–XV, 26 text-figs.

the minute structure of the nephridia, made partly on fresh, partly on fixed material, form an important contribution to cytological knowledge.

He finds that leucocytes ("excretophores") play an active part in the process of excretion. Arising from the cœlomic epithelium, they become filled with excretory products in the lymph vessels, and then either migrate to the funnel apparatus of a nephridium, where they are broken up and give off their products to the canal cells of the nephridium, or else pass by amœboid movements through the walls of the lymph vessels and the muscle layers of the body to the epidermis, there to disintegrate. In either case they form the vehicle for the transportation, partial or complete, of excretory products to the surface of the body.

Pigment cells, the author finds, are a special variety of "excretophore," in which the excretory substance assumes a particular color as the cell passes to the epidermis. The formation of a definite color pattern in the leech is explained as the purely mechanical result of the migration of pigment cells along the path of least resistance toward the surface of the body. This leads to the aggregation of pigment in particular regions of the epidermis, especially between bundles of longitudinal muscles and in places where dorso-ventral muscles have their attachments. The foregoing explanation, perhaps, accounts adequately for such markings as simple longitudinal striations of a uniform color, but, in the opinion of the reviewer, fails to explain the more complicated color patterns of many leeches, in which corresponding regions of successive somites may be pigmented very unequally or in colors strikingly contrasting.

W. E. C.

The Resources of the Sea. — Professor W. C. McIntosh's volume, *The Resources of the Sea as shown in the Scientific Experiments to test the Effects of Trawling and of the Closure of Certain Areas off the Scottish Shores* (London, C. J. Clay & Sons, 8vo, 248 pp., illustrated), sheds a deal of light on a very complex problem. It treats mainly of the Scottish fisheries, those of St. Andrews Bay, the Frith of Forth, Moray Frith, and the Frith of Clyde, but summarizes on British fisheries in general. The experiments tabulated cover a period of ten years or more; they relate to the effects of the use of trawls on the abundance of fishes, on the young, on the eggs, and on the food, and also to what may be effected in the way of replenishment by closure of particular areas. The value of the book

is in keeping with the reputation of the author. His data, however, are not such as he would have chosen and are subjected, in cases, to severe criticism; he had to accept what was provided. In purpose the experiments were to direct legislation on British fisheries, but the conclusions may be applied to any marine fishery. Some fishes, cod, herring, and mackerel, for instance, are said to be inexhaustible and need no protection; others may be temporarily reduced in numbers by the fisherman. Of these latter the impoverishments are only temporary and are self-curative; nature restores and maintains the balances; extermination, as a result of man's efforts, is apparently impossible. Extended series of thorough scientific investigations are shown to be of the greatest need; for, admitting that it is not possible to exterminate, and that overfishing, through rendering the grounds unprofitable, brings its own correction, the vital question is how best to prevent depletion and to keep up the supply all the time. Aside from the species, each of the various localities must eventually be made a subject of special study, since they differ in readiness of recovery; few are so well situated for prompt renewals as the British Isles, in the broad sweep of the Gulf Stream. The author makes the statement that the California gray whale, *Rachianectes glaucus*, has been entirely destroyed by man.

"Les Oiseaux" is apparently the second volume in a series of handbooks on the fauna of France.[1] There is an introduction of two pages on the anatomy of the bird; the rest of the volume is made up of keys to the families, genera, and species of all birds which have been known to occur in France. There is also a brief description of each genus and species, with woodcuts of the heads of nearly every species, and many drawings of the whole bird. The status and distribution of each species are indicated.

The drawings are in the style of the early part of this century; the center of gravity is rarely over the bird's base, and if two birds of the same genus are represented, their bills differ so widely that they might almost belong to different families. The nomenclature and classification are equally antiquated; six orders include the birds which, in a British manual, are divided into seventeen. The descriptions are apparently faithful, and the small compass of the book will doubtless recommend it to field naturalists.

[1] Acloque, A. Faune de France, *Les Oiseaux*. Paris, J. B. Baillière et Fils. pp. 87–336. 621 figs.

We note several American stragglers: the robin, of course, Swainson's thrush, yellow-billed cuckoo, several waders, and the American bittern, appearing strangely as *Botaurus freti-hudsoni* (Briss.).

R. H.

Heliotropism of Cypridopsis. — The reactions of a representative of the Ostracoda, *Cypridopsis vidua*, to light have been studied by Elizabeth W. Towle.[1] This animal, when dropped into the middle of a trough which is in the course of light rays from a Welsbach burner, may move either toward the source of light or away from it. Observation of individuals shows that an animal may at one time be positive, at another negative. One cause of this variation is found to be "contact." For, however strongly negative an animal may be, it can be rendered positive by being repeatedly taken up in a pipette or by disturbance of the water.

If while a Cypridopsis is moving toward the light the burner be shifted to the opposite end of the trough, the animal will immediately turn and follow it, thus keeping up a positive reaction. Likewise, if it is moving away from the light it may be observed to change its course each time the light is moved, or, in other words, to maintain its negative reaction. The only difference is this: "In all cases the positive response was temporary, while the negative one persisted as long as the animal could be kept in motion." Contact with the sides of the trough or pipette or with obstructions therein causes a change from negative to positive; whereas the change from positive to negative occurs independently of external conditions.

Miss Towle's experiments indicate that Cypridopsis cannot be characterized as positively phototactic, and the use of an India-ink prism as a means of getting regular gradations of light intensity led her to conclude that a photopathic reaction (*i.e.*, a response to difference of intensity of adjacent rays and not to the direction of the same) has *not* been proved thus far for any animal, and probably does not exist. As a result of careful tests with the prism she decides that "the direction of movement of Cypridopsis and of Daphnia in response to light does not result from an effort on the part of the animal to reach a certain optimum intensity. It is determined (1) by the direction of the impinging rays, and (2) by the relative value of these rays as forces acting upon the organism, *i.e.*, by their relative intensities."

[1] A Study in the Heliotropism of Cypridopsis, *Amer. Journ. of Phys.*, vol. iii (1900), No. 8.

The investigation is valuable, in that it reveals the importance of "contact" as a factor in the reactions of Cypridopsis to light. The problem has been suggested, rather than analyzed, by the author, and it demands further attention. Obviously the observations fail to disprove the possibility of photopathy or the selection of an optimum intensity, although they do emphasize the importance of the rays' directive influence.

R. M. YERKES.

Notes. — *Circular No. 40*, second series of the Division of Entomology of the United States Department of Agriculture, dealing in a brief synoptical way with the mosquitoes of North America, is of unusual general interest, since it renders evident, at a glance, whether or not a prevalent mosquito belongs to the genus Anopheles, which appears to comprise the species by which human malaria is chiefly, if not exclusively, spread.

Professor E. S. Morse, in "A Bubble-Making Insect" (Appleton's *Popular Science Monthly*, May, 1900), discusses the fluid accumulations of the Cercopidæ. A "look over the literature of the subject," considered "sufficient to indicate the common belief among entomologists," cites no authority later than 1869. In writing for general readers, the latest works, rather than the earlier classics, should be quoted, and even a "superficial survey" of what has been published on the subject, if directed aright, would not have been so wholly barren as Professor Morse's paper would indicate. The froth is stated to act as a protection against enemies; certain Hymenoptera, however, provision their nests with young cercopids selected from the spits.

In a separately paged extract from the Fourth Annual Report of the Commissioners of Fisheries, Game, and Forests of the State of New York, Dr. E. P. Felt gives an account of seven insects injurious to maple trees. The species treated are the white-marked tussock moth, *Notolophus leucostigma*, forest tent caterpillar, *Clisiocampa disstria*, leopard moth, *Zeuzera pyrina*, maple sesian, *Sesia acerni*, sugar-maple borer, *Plagionotus speciosus*, maple-tree pruner, *Elaphidion villosum*, and cottony maple-tree scale, *Pulvinaria innumerabilis*. The descriptions, though brief, are accurate and adequate, and with the illustrations make the recognition of the several species easy. The title-page and cover read, "Insects injurious to forest trees, 1898." The title line, however, gives, "Insects injurious to maple trees," and at the very outset Dr. Felt states his reasons for confin-

ing his report to insects affecting shade trees. He also records the result of observations made in 1899.

Messrs. Henry Holt & Co. publish (New York, 1899) a new issue of Scudder's *Brief Guide to the Commoner Butterflies of the Northern United States and Canada.* The text shows but slight change from the original of 1893. The illustrations, borrowed from other works, are new to this issue, and give, with varying success, figures of the eighty-four species treated in the text.

"The Recognition of the Poisonous Serpents of North America," an address with a demonstration to the graduating class in the medical school, before the Johns Hopkins Medical Society, by Professor Howard A. Kelly, is printed in the *Bulletin of the Johns Hopkins Hospital*, Vol. X, No. 105. Figures of six snakes, three poisonous species and three harmless species, illustrate the paper. The disadvantages under which a physician labors when dealing with a purely zoölogical subject are clearly shown in the text.

BOTANY.

An Experimental Botany. — Teachers who believe in approaching the study of plants from the physiological point of view will welcome Dr. MacDougal's latest guide.[1] The book is intended for the use of beginners who have not the facilities of a laboratory. Only a hand magnifier and such apparatus as may be extemporized readily with the aid of household articles are required in the observations and experiments to which the student's attention is directed. It will be a surprise to many teachers to find how fully the more important general principles of plant physiology may be illustrated by these simple experiments, while the young people who perform the experiments cannot fail to be delighted with what they will witness, and be led to valuable general ideas of plant life. The book abounds in fresh and inspiring suggestions.

It must be said, however, that users of the book are assumed to have acquired sufficient knowledge of systematic botany and facility

[1] MacDougal, Daniel Trembly, Ph.D., Director of the Laboratories, New York Botanical Garden. *The Nature and Work of Plants: an Introduction to the Study of Botany.* New York, The Macmillan Company, 1900. Cloth, 12 mo. xvii + 218 pp.

in the determination of species to enable them to make ready use of such works as *Gray's Manual* and *Britton and Brown's Flora*. No help in learning how to analyze is here afforded, although the student is expected to determine during the course a considerable number of plants. To call the book "An Introduction to the Study of Botany" would seem to be, therefore, somewhat misleading.

The prominence given to physiological matters leaves opportunity for but scant consideration of the form and structure of parts — scarcely enough, it would seem, for a full understanding of the text, except on the supposition that the student is receiving or has received supplementary instruction. Some of the morphological statements call for correction. Thus we find fruit defined as "the seed and all parts of the ovary adhering to it" (p. 155) — a strangely inadequate definition, which is contradicted by the statement (on p. 176) that the "fruit of the apple is composed of portions derived from all the organs of the flower." It seems strange, also, to find such an unqualified statement of this old notion of the apple's morphology, in view of the simpler modern theory now generally adopted.

As regards physiological matters the treatment leaves but little to be desired. One statement, however, would seem to require modification, namely, where it is said (on p. 45) that the spongy layer enveloping the roots of air plants will "gather water from the air when it is humid and damp." The careful experiments to test this matter by R. G. Leavitt, detailed in *Rhodora* for February and March, 1900, make it appear highly improbable that aërial roots ever have this power of absorbing watery vapor which has been frequently ascribed to them on meager evidence.

In spite of its defects, which are not likely to prove of much consequence where there is a good teacher, the book is sure to rank well among recent helps to the study of plants as living things.

F. L. S.

Prantl's Lehrbuch.[1] — The new edition of Prantl's excellent text-book of botany follows essentially the same lines as the last edition, the chief modifications consisting of a general expansion which amounts to about fifty pages. Numerous changes and additions in the matter of illustration have resulted in an increase of twenty-seven cuts. Several of these new cuts illustrate the micro-

[1] Prantl. *Lehrbuch der Botanik*, herausgegeben und neugearbeitet von Dr. Ferdinand Pax. Elfte, verbesserte und vermehrte Auflage. Leipzig, Engelmann, 1900. 456 pp., 414 figs.

scopic structure of drugs. Another feature of pharmacognostical interest is an appendix of about ten pages, giving a brief synopsis of the officinal plant drugs of the German Pharmacopœia.

The subjects usually treated in books of this class are here presented in a clear, concise text, which is very effectively supplemented by the excellent woodcuts.

It is hardly necessary to point out the good qualities of a book that has proved its usefulness by long service. It is enough to say that it is distinctly improved in the new edition and will remain one of the most serviceable of the shorter botanical text-books.

R. H. T.

"Lessons in Botany." [1]—The increased attention to botany in high-school courses during the last few years has resulted in a rich crop of elementary texts designed to meet the new conditions. In the preparation of many of these texts it has been assumed that a full year's time could be given to this subject. Very many schools, however, are not yet able to devote more than a half year to the study of plants, and abridged editions are consequently beginning to appear.

Atkinson's *Lessons*, a volume of three hundred and sixty-five pages, is such a work. The opening chapter on germination, winter buds and shoots, is succeeded by the study of protoplasm and its properties, as observed in root hairs, Spirogyra, and Mucor. About eighty-six pages are given to a study of the physiology of flowering plants. Part II, dealing with the morphology and life history of representative types, begins with Spirogyra and Vaucheria, following the usual sequence up through the ascending series of forms. When the study of the angiosperms is taken up a chapter on seeds and seedlings is introduced. Here the types discussed differ from those in the opening chapter.

Part II is concluded by Studies on Plant Families. Twenty or more lessons are devoted to the morphology and ecology of about as many plants. Part III, including about sixty pages, is given up to ecology. So far as the ecological adaptations of the individual plant under ordinary conditions is concerned, this phase of botany seems admirably adapted for use in the high school; but when the study of plant communities introduces zones of tension and other landscape features the value of the subject in a half year's high-school course is doubtful. Descriptions of swamps near Ithaca can hardly take

[1] Atkinson, George Francis. New York, Henry Holt & Co., 1900. 365 pp., 277 figs.

the place of work afield, for which the students whom this book is designed to aid are likely to lack time and opportunity. With this exception the *Lessons* seem to the writer well adapted to the ends they are intended to meet.

The author has an interesting style of presentation. The abundant illustrations, of which many are original, are very good.

R. H. T.

Notes. — Part I of *The Queensland Flora*, a handbook by F. Manson Bailey, Colonial Botanist, recently issued, contains the orders Ranunculaceæ to Anacardiaceæ and is illustrated by twelve plates representing some of the rarer species.

Volume II of the *Meddelanden* of the Botanical Institute of the Stockholm University contains thirteen articles covering morphological and physiological studies on flowering plants and morphological and taxonomic studies on certain cryptogams, chiefly fresh-water algæ.

Mr. Holm's *Studies in the Cyperaceæ, XII*, deals with *Carex filifolia* Nuttall, from which are segregated *C. elynoides* (*C. filifolia* var. *miser*) and *C. oreocharis* (*C. filifolia* var. *valida*).

Messrs. J. U. and C. G. Lloyd, of Cincinnati, whose practical interest in botany has been shown already in many ways, have begun the publication of a "reproduction series" of Bulletins, the first of which, fresh from the press, is a facsimile of Barton's *Collections for an Essay towards a Materia Medica of the United States*, accompanied by a biography and portrait of the author.

PALEOBOTANY.

Cretaceous Plants.[1] — Professor Lester F. Ward, with the collaboration of W. P. Jenney, W. M. Fontaine, and F. H. Knowlton, presents an elaborate discussion of the cretaceous flora of the Black Hills in relation to the geological age of the various strata in which the plants occur. Eighty-six species are enumerated, of which nineteen belong to the Pteridophyta, forty-eight are gymnosperms, and the

[1] Ward, Lester F. The Cretaceous Formation of the Black Hills as indicated by the Fossil Plants, *U. S. Geol. Surv.*, 1899, pp. 525–712, Pls. LVII–CLXXII.

remaining seventeen belong to the angiosperms. Special interest centers in the very large number of cycads, — twenty-five species in all, — which were obtained in a remarkably fine state of preservation. Of these, twenty species belong to the Cycadoidea, the majority of the specimens (126) belonging to the Marsh collection of the Yale Museum.

A critical comparison of the flora of the various horizons with corresponding types and formations elsewhere in America and Europe leads the author to the unqualified conclusion that "the sandstones of the Black Hills belong to the Dakota group proper, or No. 1 of Meek and Hayden, while the recent contention that the cycad and other plant-bearing beds form a part of the Jurassic may be regarded as definitely overthrown."

D. P. P.

Fossil Cycads.[1] — Professor Lester F. Ward continues his studies of fossil cycads by a notable contribution to the Washington Academy of Sciences on twenty new species from the Jurassic of Wyoming. This material first came to notice in 1898, through Professor O. C. Marsh, and since then a large amount of additional material in the form of well-preserved trunks has been obtained. It is a noteworthy fact that these fossils not only represent new species, but they also represent an entirely new genus, for which Professor Ward proposes to use the name of Cycadella. The chief points of contrast with the cycads of the Black Hills are to be found in the relatively small, bulbous, subspheroidal, or subconical trunks, which are encased in a layer, 5–15 mm. thick, of dense tissue consisting of a chaffy ramentum, which arises from the leaf bases and becomes matted so as to form a thick outer covering.

D. P. P.

Fossil Cycads.[2] — The very remarkable collection of cycads from the Black Hills and other localities, brought together by the late Professor Marsh and now to be found in Yale Museum, has led Mr. G. R. Wieland to supplement the admirable studies of Professor Ward by a more detailed macroscopic and microscopic examination of these plants in all their parts. His preliminary studies give important details respecting the character of the inflorescence, the structure of

[1] Ward, Lester F. Description of a New Genus and Twenty New Species of Fossil Cycadean Trunks from the Jurassic of Wyoming, *Proc. Wash. Acad. Sci.*, 1900, vol. i, pp. 253–300, Pls. XIV–XXI.

[2] Wieland, G. R. A Study of Some American Fossil Cycads, *Amer. Jour. Sci.*, 1899, vol. vii, pp. 219, 305, 384.

the foliage, and the nature of the fructification in *Cycadoidea ingens* and *C. wielandi*. The superb character of this collection, both in extent and perfection of preservation, as also in the very unusual fact that the inflorescence is preserved in great perfection of detail, leads us to hope for the most important results bearing upon our knowledge of the earlier history of these very interesting plants, and botanists will look forward with keen interest to the completion of these important studies.

D. P. P.

The Yale Collection of Cycads.[1]— Mr. G. R. Wieland contributes a short account of the very remarkable collection of cycads now in the Yale Museum, which will prove of interest to paleobotanists as a concise account of the origin, number, and general character of these valuable specimens. In the Yale collection there are many beautiful cycadean fronds from the Triassic sandstones of the New Haven region, and more than six hundred silicified trunks chiefly from the Upper Jurassic of the Black Hills. In addition to these, the fact of three other American collections in the United States National Museum, the University of Wyoming at Laramie, and at the Woman's College, Baltimore, is noted. Figures and general descriptions of thirteen species are given.

D. P. P.

Fossils of the Norwegian North Polar Expedition.[2]— An interesting result of the Nansen Expedition comes to us in the form of a paper by A. G. Nathorst on the "Fossil Plants from Franz Josef Land." Twenty-nine species in all are described, and one fungus parasite on a coniferous leaf. The plant-bearing stratum lies between two basalt beds, and a comparative study shows that it is in all probability Jurassic, the flora corresponding most nearly with that from the Jurassic of Siberia and Spitzbergen. The unfortunately fragmentary condition of the material leaves much in doubt as to the specific identity of several species, as well as of the exact horizon to which they belong. The following summary of species may be found of interest: Cladophlebis 1, Sphenopteris 4, Pterophyllum 1, Podozamites 1, Ginkgo 3, Czekanowskia 1, Phœnicopsis 1, Fieldenia 1, Taxites 1, Abietites 1, Pityanthus 1.

D. P. P.

[1] Wieland, G. R. *The Yale Sci. Monthly*, 1900, vol. vi, pp. 1–11, 2 plates.

[2] Nathorst, A. G. The Norwegian North Polar Expedition, 1893–1896. III, Fossil Plants from Franz Josef Land, pp. 3–26, Pls. I, II. Longmans, Green & Co.

Rothamsted Experiments.[1] — The present account by Lawes and Gilbert continues the results derived from forty-four years of continuous experimentation upon the same land. The general results so far reached show very characteristic differences in the composition of the ashes of different crops according to the amount of nitrogen they assimilated; and upon this is based the conclusion that "independently of any specially physiological function of the bases, such as that of potash with the formation of carbohydrates, their office was prominently also that of *carriers of nitric acid*, and that when the nitrogen had been assimilated, the base was left as a residue in combination with organic acid, which, according to the character of the plant, was represented more or less completely by carbonic acid in the ash."

D. P. P.

Plants in Calcareous Tufa.[2] — Mr. J. M. Hulth presents an interesting study of the plants found in the calcareous tufa of western Gothland in the region of Falköping and Sköfde, and discusses the vegetation of seven different horizons with respect to their relation to the flora of the Arctic, Boreal, and Atlantic periods. The vegetation found corresponds with existing types.

D. P. P.

Fossil Flora of the Cascade Range.[3] — Studies of the fossil plants associated with the lavas of the Cascade Range, prosecuted during the last five years, have been completed by Professor F. H. Knowlton. Twenty-eight forms in all are described, and they include such types as have hitherto been found in the Miocene only, from which the author concludes unhesitatingly that the beds are of Miocene age.

D. P. P.

Flora of the Coal Layers of Là Ternera.[4] — Solms-Laubach presents a short account of the plants derived from the Coal Formation

[1] Lawes, Sir J. B., and Gilbert, Sir J. H. Agricultural, Botanical, and Chemical Results of Experiments on the Mixed Herbage of Permanent Grass Land; III, Chemical Results, *Phil. Trans. R. Soc.*, vol. cxcii (1900), pp. 139–210.

[2] Hulth, J. M. Ueber einige Kalktuffe aus Westergötland, *Bull. Geol. Inst. of Upsala*, 1898, vol. iv, pp. 5–40, Pl. I.

[3] Knowlton, F. H. Report on the Fossil Plants associated with the Lavas of the Cascade Range, *U. S. Geol. Surv.*, vol. xx, III, 1898–99, pp. 37–52, Pls. I–VI.

[4] Solms-Laubach, H. von Grafen zu. *Neue Jahrb. f. Mineral.*, etc., vol. xii, 1899, pp. 581–609, Pls. XIII, XIV.

at La Ternera, Chili. Ten species of gymnosperms and ferns are enumerated, and they serve to indicate that the beds belong to the Lower Lias. D. P. P.

PALEONTOLOGY.

Notes on Fossil Fishes. — In the *Bulletin of the Geological Society of America* Mr. C. R. Eastman has an account of the fossil fishes of Jurassic formations in the Black Hills of South Dakota. The paper is supplementary to one by N. H. Darton on the same subject. The Jura-Trias of America has yielded very few fishes, and the scanty remains noted by Mr. Darton and Mr. Eastman represent about all that is known of the fish fauna of the period as represented in American deposits. In the present paper are given descriptions and photographic representations of *Pholidophorus americanus* and *Amiopsis* (?) *dartoni*. The relations of Pholidophorus are discussed in some detail, it being regarded as the type of a distinct family, Pholidophoridæ.

In the *Memoirs of the New York Academy of Sciences* Dr. Bashford Dean discusses the relationships of the alleged fossil lamprey of the Devonian, *Palæospondylus gunni*. In Dr. Dean's view this species is not a lamprey, nor related to the cyclostomes. It is probably a larval form, possibly of the Arthrodira genus Coccosteus. The Arthrodira, according to Dr. Dean, "cannot be strictly included among the fishes," and with their relatives (Anarthrodira), all also extinct, should be placed in a distinct class, Arthrognathi, by themselves.

In the *Journal of Geology* Mr. C. R. Eastman describes and figures the teeth of a number of Devonian fishes, the following being described as new: *Cladodus monroei*, from the Hamilton formation at Milwaukee; *Dipterus uddeni* and *D. calvini*, from the Middle Devonian, New Buffalo, Iowa; *D. costatus* and *D. mordax*, from North Liberty, Iowa. D. S. J.

A slab of limestone with numerous specimens of *Uintacrinus socialis* Grinnell, recently placed on exhibition in the Yale University Museum, is noticed and figured in the April number of the *American Journal of Science*. A similar and somewhat larger slab in the Museum of Comparative Zoölogy is figured in the Annual Report of the Museum for 1898–99.

NEWS.

THE Academy of Natural Science of Philadelphia receives by the will of the late Charles E. Smith one-sixth of his estate, which is valued at about $500,000. His collections and botanical library also go to the academy.

Dr. James M. Safford, the state geologist of Tennessee and professor in Vanderbilt University, retires at the end of the present year.

The University of the State of Missouri is to send an Entomological Expedition into southern Mexico this summer. It will be in charge of Professor J. M. Stedman, head of the entomological department, and will have for its object the making of a biological, largely entomological, survey of the region from Vera Cruz, on the Gulf, which is in perpetual tropics, to the top of the volcano Popocatepetl, which is far above the perpetual snow line, and down to Acapulco on the Pacific. This will give all the temperature variations from perpetual tropics to perpetual snow, and will allow of the study of life zones under conditions not to be found elsewhere in North America. The collection will become the property of the university, which is to furnish half the expenses, the other half to be borne by Professor Stedman.

Appointments: Dr. Charles W. Greene, professor of physiology in the University of Missouri. — Mr. S. Harbert Hamilton, assistant in the museum of geology and archæology at Princeton University. — Dr. Franz Kossmat, docent in geology in the University of Vienna. — Dr. Paul Ehrenreich, docent in ethnology in the University of Berlin. — Stuart Weller, instructor in paleontology in the University of Chicago. — Alfred L. Kroeber, curator of anthropology in the California Academy of Sciences. — Dr. A. L. Treadwell, professor of zoölogy in Vassar College. — R. H. Yapp, assistant curator of the herbarium in the University of Cambridge.

DEATHS. — Dr. George Viner Ellis, for many years professor of anatomy in University College, London. — Dr. Bernhart Nöldeke, assistant in zoölogy in the University of Strassburg. — Lieutenant-General A. H. Lane-Fox Pitt-Rivers, the well-known English ethnologist, in London, May 4, aged 73. — George Highfield Morton, an English geologist, aged 73.

NOTE.

Organs of Vision. — Dr. Theodor Beer, whose valuable studies on the sensory organs of both vertebrates and invertebrates are well known, is engaged in writing a comprehensive work on the *Comparative Anatomy and Physiology of the Organs of Vision*, and to make this as complete as possible he is anxious to acquire separates of all articles — for which, if desired, he will send his own writings in exchange — dealing in any way whatever with the anatomy, embryology, zoölogy, pathology, or literature of the organ of sight in animals or the eye of man, or with reactions to light. Dr. Beer is particularly desirous that none of the widely scattered writings of Americans should escape his attention and, therefore, especially invites the coöperation of all Americans who can aid him.

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PUBLICATIONS RECEIVED.

(Regular exchanges are not included.)

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CHITTENDEN, F. H. Some Insects Injurious to Garden Crops. United States Department of Agriculture, Division of Entomology. *Bulletin No. 23.* 92 pp. — COQUILLET, D. W. Report on a Collection of Dipterous Insects from Puerto Rico. *Proc. U. S. Nat. Mus.* Vol. xxii. pp. 249–270. — HAY, O. P. Descriptions of Some Vertebrates of the Carboniferous Age. *Proc. Amer. Phil. Soc.* Vol. xxxix, No. 161, pp. 96–123. — MORSE, E. S. A Bubble-Blowing Insect. *Popular Science Monthly*, p. 23. May, 1900. — RATHBUN, M. J. The Decapod Crustaceans of West Africa. *Proc. U. S. Nat. Mus.* Vol. xxii, pp. 271–316.

American Museum Journal. Vol. i, No. 1. April. — *Bulletin Geographical Society of Philadelphia.* Vol. ii, No. 5. March. — *Bulletin of the Johns Hopkins Hospital.* Vol. xi, Nos. 109, 110. April and May. — *Bulletin of the Natural History Society of New Brunswick.* Vol. iv, No. 18, Pt. iii. 1899. — *The Forester.* Vol. vi, No. 5. May. — *The Insect World.* Vol. iv, No. 4. April. — *Proceedings of the Rochester Academy of Science.* Vol. iii, Pt. ii, pp. 151–230. March. — *Revista Chilena de Historia Natural.* Ano iv, Nos. 2–3. February and March. — *Science Gossip.* New Series. Vol. vi, No. 72. May. — *Johns Hopkins Hospital Reports*, vol. vii, Nos. 5–7, contains Bloodgood, J. C., Operation on 459 Cases of Hernia, etc., pp. 224–567, plates. — Wisconsin Geological and Natural-History Survey, *Bulletin Nos. 5–6*, contains Grant, U. S., Preliminary Report on the Copper-Bearing Rocks of Douglas County, Wis., 55 pp., and Salisbury, R. D., and Atwood, W. W., The Geography of the Region about Devil's Lake and the Dalles of the Wisconsin, 151 pp., plates.

(*No. 402 was mailed June 21.*)